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ARCHITECTVRE

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House for Gorham Thurber, Esq., Providence, R. I.
(Gelatine Print issued only with Imperial Edition.)

Design for Club-house, Sedgemere, L. I.

First M E Church, Wilkes-Barre, Pa.

Normal School, Moorhead, Wis.

Melrose Hall, Oak Lane, Pa.

"Shingle-nook," House at Narragansett Pier, R. I.

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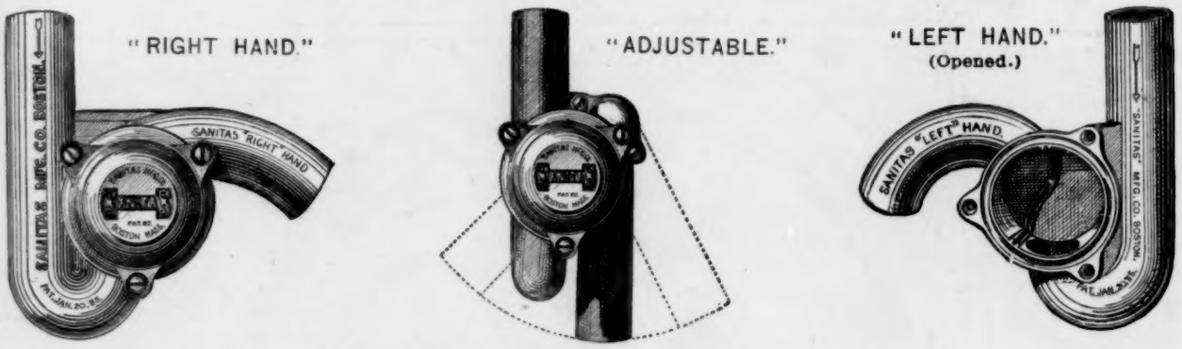

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A CURIOUS accident occurred recently in New York, the result of which may have a good deal of interest to owners as well as builders. A contract had been made for the removal of a building on the corner of Broadway and John Street, to make room for new constructions, and the contractor, Mr. Southard, was at work with his men, when a floor fell, killing one and injuring several others of the workmen. On examination, it was found that the beams of the floor which fell had been cut short of the inner wall, and, instead of being built into the brickwork, rested at that end on a strip of wood an inch and a half thick, which was nailed to the side of heavy headers, running parallel to the wall. At the outer ends, the beams seem to have been built into the wall in the usual way. The beams are said to have been shorter even than the bearing, and to have rested only one inch on the strip nailed to the header. A further examination, according to the New York *Tribune*, showed that none of the other floors were framed in the same way, and no reason can be found for constructing this one in so peculiar a manner, unless we suppose that the original builders utilized in that way, as the builders of fifty years ago occasionally appear to have done, some timbers too short to run entirely across the building. The coroner's inquest has not yet been held, but the coroner seems to be of the opinion that Mr. Southard will not be held responsible for the accident. In that case it will be interesting to learn who, if any one, will be held so responsible. It is to be presumed that the injured men, and the representatives of the one who was killed, will make a claim on some one for damages. The usual course in such cases is to try to hold the owner of the building accountable, for the reason that he is most likely to have the means of paying the money, if judgment should be given against him. Whether this can be done here is a nice question. Evidently, if the floor fell from defects frequently occurring in such buildings, the contractor would have been in fault for not having guarded against them. If, however, defective construction of this sort is so rare that a man making a business of removing old buildings would not be likely to have met with it, or to have had reason to suppose that it might exist, he would be relieved of responsibility, on the principle, which has been recently maintained by a Missouri court, that the owner is supposed to furnish to a contractor for removal a building of the ordinary kind, free from concealed defects of a sort so unusual that a contractor could not reasonably be expected to think of, and guard against them. In that event, the contractor being exonerated from liability to the injured workmen, there would seem to be a question whether the owner could be compelled to assume that liability. As between the owner and contractor, it seems fair enough that the latter should not be obliged to assume burdens coming from unexpected peculiarities about the building to which his contract related; but whether, the innocent ownership of a structure in which hidden peculiarities exist involves responsibility for accidents arising from them is another matter, on which a good deal of legal wisdom might be expended.

WE are inclined to think that the English and French auctioneers of objects having any historical interest would do well to advertise their collections in the American newspapers, long enough beforehand to enable amateurs to cross the water to attend the sales. A few weeks ago a collection of singular interest was sold at auction, consisting of pieces of furniture belonging to the estate of the late George Godwin, nearly every one of which had once been the property of some very distinguished person. Mr. Godwin had for many years interested himself in forming the collection, and the history of all the pieces had been clearly established, yet the prices obtained for the various articles were, as most Americans would think, far beneath their value. The "crown of the collection," as it was described in the catalogue, was an arm-chair which once belonged to William Shakespeare, and was said, upon what authority it would be interesting to know, to have been occupied by him during the composition of many of his plays. This piece of bric-à-brac brought something over six hundred dollars, not much more, by the way, than we have known paid in New York for an old Belgian arm-chair, taken, we believe, from the sacristy of a church, but otherwise of no historical interest whatever. The next piece to this was Nathaniel Hawthorne's arm-chair, a folding affair, painted, which brought three dollars and seventy-two cents — about what most Americans would be willing to pay for the bare privilege of looking at it, and less than the price which any such object, if in decent condition, would command in an American second-hand furniture store. An arm-chair which once belonged to Sir Walter Raleigh was sold for ten dollars, a price which, we should think, would have brought Hawthorne himself from the grave to bid upon it. Two chairs once owned by the first Napoleon brought seven dollars and a half each, and his mahogany coffee-table, from St. Helena, fifteen dollars. Lord Byron's arm-chair sold for thirteen dollars, a chair which was used by Anne Boleyn during her residence at Hever Castle brought fifty-four dollars, and another, occupied by King Charles the Second at his councils at Yarmouth, brought fifty-two dollars. There are in New York several people who would, we think, cheerfully pay about fifty-two dollars a week for the privilege of exhibiting a Charles II chair in their front hall, and as many more who would think the same rental not very excessive for an authentic piece of Anne Boleyn's property, yet the London bric-à-brac buyers, who will pay forty thousand dollars for a Riesener cabinet, apparently consider that the attraction given to a piece of furniture by its association with the beautiful and unhappy mother of the great Elizabeth is nothing in comparison with the glitter of brass inlays and ormolu.

THE subject of masonwork in freezing weather continues to occupy a good deal of attention in the technical journals. The stories of the excellence of stonework laid with hot mortar in Stockholm and other Northern cities in winter, and then allowed to freeze, have multiplied, while, on the other hand, a recent report by an American engineer, Mr. Emil Kuichling, appears to show conclusively that mortar, particularly if made with cement, and used hot, lost a large part of its strength; the resistance, as determined by actual experiment, of briquettes of neat cement, mixed hot, and then exposed for seven days to the air, being, on an average, only one-eighth that of briquettes of the same cement, mixed at the same time, with water having the temperature of the air, and then exposed in the same way. Curiously enough, briquettes made with Portland cement and cold water would not freeze, even at a temperature of thirteen degrees Fahrenheit, unless exposed to the wind, and the setting process appeared to go on undisturbed even at this temperature; while briquettes made of the same cement, mixed with hot water, invariably froze. With natural cements the resistance to freezing was much less than with the Portland, but no details are mentioned on the subject. The addi-

tion of salt to water, sometimes made to prevent freezing, is found to injure native cements, while Portland is not affected.

THE archæological world mourns the loss of the man who, almost unassisted, made known to Americans the fact that their country had an early history of no small interest, and, by his explorations, raised the mounds of the Mississippi Valley, long regarded as the idle work of a brutish race, to the rank of evidences, not merely of ethnological changes, but of an interesting and tolerably well-developed aboriginal civilization. This earnest explorer was Dr. Edward Hamilton Davis, a distinguished physician of New York, who, after his fortune and reputation were made in his profession, employed his leisure in a study of American antiquities which extended over about thirty years, and made him one of the principal authorities on the subject. The race of Mound Builders attracted most particularly his attention, and at his own expense he opened nearly two hundred mounds, gathering a very large collection of objects from them, many of which, strangely enough, have found their way to England, where they form a part of the well-known Blackmore Museum at Salisbury, perhaps the most interesting collection of American antiquities to the amateur that is to be found anywhere. These explorations he described in a book on the "*Ancient Monuments of the Mississippi Valley*," which is one of the classics of American archæology.

LE GENIE CIVIL calls attention to a financial chimera which has already made many victims abroad, and is likely to make more here if it is not exposed. In the latter part of last year, it says, a great deal of noise was made in the English papers about an automatic machine for making bottles, which had been invented by one Ashley, and, on being fed with melted glass, blew, by a jet of compressed air, just the required quantity of glass into the given mould to produce a perfect bottle. In this way, it was claimed, the cost of manufacture was greatly reduced, and, the quantity of glass taken and the force of the jet of air being automatically regulated, there was never any loss from waste or defective work. Patents had, it appeared, been taken out for this invention in all civilized countries, and a company had been formed, under the name of the European and American Machine-made Bottle Company, Limited, with a capital of three million dollars, to engage in manufacturing under these patents. It would seem as if a company with a capital of three millions, a large part of which had already been subscribed, need not wait long before commencing operations, but so far, we believe, no manufacturing has been done, and the German technical journals explain this by asserting that it cannot be done in the way described. In one of these journals Mr. Frederic Siemens asserts that no attempt at automatic glass-blowing has ever yet succeeded, and that it is apparently impossible to measure mechanically the force and volume of air required for inflating a bubble of melted glass. As to the European-American Company, he says further that the representations of its prospectus in regard to the capacity of the Ashley machines are inconsistent with each other, and with any reasonable estimate of the speed with which the machine can be operated and material supplied, while the claims of the promoters of the Company in regard to the profits to be expected from the enterprise are founded on statistics of the consumption of bottles in Europe which are grossly erroneous. The sequel to Mr. Siemens's criticisms on the project seems to have appeared in an advertisement which was published last March in a London paper by the counsel for several of the stockholders, inviting the persons interested to unite in an appeal to the courts against the promoters and directors of the company, for having invited subscriptions by a prospectus filled with errors and fabrications.

IT is pleasant to learn that those dreaded foes of the human race, the bacteria, have found an enemy in a tribe of phagocytes, who inhabit the human organism, and endeavor to devour the bacteria, with a degree of success varying with circumstances. These phagocytes, which are otherwise sometimes known as leucocytes, consist of cells, composed of protoplasm, which exist in the blood, and, on the apparition of wandering bacteria, seize and envelop them with protoplasm, in which they become disintegrated and disappear. According to Dr. Metschnikoff, who has seen the bacilli of the charbon virus, perhaps the most malignant infection known, seized and destroyed by the white cells in the blood of a frog, the energy of the action depends greatly upon the temperature, and a frog which easily resisted the charbon infection at ordinary temperatures, was found to become susceptible to it when the temperature was raised to ninety-eight or ninety-nine degrees Fahrenheit. That there is a connection between the absorption of the bacilli by the cells and the diminution of the violence of infectious disorders seems to be quite probable, and Dr. Metschnikoff has found that in mild cases of erysipelas the blood showed multitudes of the characteristic bacteria of the disease fixed in the protoplasm of the white cells, but few or none floating free, while in fatal cases the bacteria were found free in great numbers, while few were fixed in the protoplasm. To the unlearned reader there seems to be a little discrepancy between these observations and those published not long ago, in which it appeared that infections communicated to poultry, by inoculation or otherwise, were arrested by placing the fowls in a high temperature, which seemed to check the growth of the bacilli and ultimately destroy them, and that even the infection of hydrophobia was successfully treated in Russia by putting the patient in the hot room of a bath-house until the attack had spent its force; but it may be that the temperature under which the action of the white cells takes place varies with different animals, and that the protoplasm of a frog is liveliest at a low temperature, while that of a hen is most energetic and voracious at a high one. The whole subject of the natural history of animalculæ needs study. For example, we have heard almost nothing of late about any investigations into the habits of the useful little creatures which live in the upper eighteen inches of the soil and eat up sewage matter. We know that they are put to sleep by chloroform and revive when the effect of the anæsthetic passes away, so they must, apparently, be endowed with some sort of nervous system, but what their habits are in other respects, or how they may be multiplied in case of need, or trained to do their work most efficiently, no one can say.

FIRE AND WATER describes what is certainly the most surprising scheme for providing escape from theatres in case of fire that has yet been devised. The plan is the invention of a newspaper man of Norwich, and consists in an arrangement of the seats, and the floor under them, by which any person in the audience who smells smoke, or is alarmed in any way, has only to touch an "electric button;" upon which a trap-door opens beneath him, and, as he sinks through it, an endless belt, or some similar contrivance, receives him and propels him through a conduit by which he is brought safe and sound to the sidewalk outside. In case all the spectators at once should be seized with panic, and touch the "electric buttons" simultaneously, a provision is made by which each one falls into a particular place on the moving belt, and is thus conveyed safely and quickly, without crowding or struggling, to the open air. As *Fire and Water* says, such an arrangement would expose incautious spectators to a chance of touching the button accidentally, and finding themselves mysteriously removed from the theatre, and thrust out into the street; but there is the germ of an idea in the scheme. In the lively discussion which has been provoked by the publication of Mr. Tarver's patented theatre plan, it has been made clear that in case of fire the upper portions of a theatre are the dangerous ones, and that the occupants of the "parterre," or floor, almost always escape, through the greater purity of the air at the bottom of the building. On this ground Mr. Tarver defends his plan of calling his audience downward and forward from their places to the exits, instead of up and backward to elevated corridors which become almost immediately filled with smoke; and the trap-door arrangement, absurd as it seems, might open a way from the suffocating auditorium to the cool, fresh air of the space beneath the fireproof floor, which would at times be of incalculable value. One merit of Mr. Tarver's scheme is, it seems to us, the retreat of the successive circles, by which the rooms beneath them are shut off from the auditorium by the iron beams and brick arches now generally used for theatre floors; and even if no endless belts were provided to propel the audience automatically into the street, it would be easy to multiply entrances, by trap-doors or otherwise, directly downward from the various circles to the rooms beneath, where fresh air would be found at once, and safety soon afterward.

SAFE BUILDING.—XXVI.[1]

CHAPTER VII.

GRAPHICAL ANALYSIS OF TRANSVERSE STRAINS.

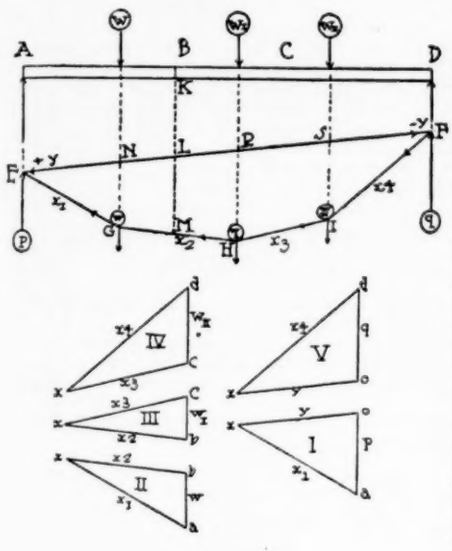


Fig. 149.

ALL the different calculations to ascertain the amounts of bending-moments, the required moments of resistance and inertia, the amounts of reactions, vertical shearing on beam, deflections, etc., can be done graphically, as well as arithmetically. In cases of complicated loads, or where it is desired to economize by reducing size of flanges, the graphical method is to be preferred, but in cases of uniform loads, or where there are but one or two concentrated loads, the arithmetical method will probably save time. As a check, however, in important calculations, both methods might be used to advantage.

Basis of Graphical Method. If we have three concentrated loads w, w_1, and w_{11} on a beam $A\ D$ (Fig. 149), as represented by the arrows, we can also represent the reactions p and q by arrows in opposite directions, and we know that the loads and reactions all counterbalance each other. The equilibrium of these forces will not be disturbed if we add at E a force $= +y$, providing that at F we add an equal force, in the same line, but in opposite direction or $= -y$.

We have now at E two forces, $+y$ and p. If we draw at any scale a triangle $a\,o\,x$ (or I) where $a\,o$ parallel and $= p$, and where $o\,x$ parallel and $= +y$, we get a force $x\,a$, which would just counterbalance them, or $a\,x$, which would be their *resultant*. That is, a force $G\,E$ thrusting against E with an amount $a\,x$ (or x_1) and parallel $a\,x$ would have the same effect on E as the two forces $+y$ and p. Continuing x_1 till it intersects the vertical neutral axis through load w at G, we obtain the resultant x_2 of the two forces acting at G, namely x_1 and w (see triangle $b\,a\,x$ or II). Similarly we get resultant x_3 at H, of load w_1 and x_2, (see triangle $c\,b\,x$ or III); also resultant x_4 at I of load w_{11} and x_3 (see triangle $d\,c\,x$ or IV); and finally resultant $+y$, at F of reaction of q and x_4 (see triangle $o\,d\,x$ or V). As this resultant is $+y$ it must, of course, be resisted by a force $-y$ that the whole may remain in equilibrium. By comparing the triangles I, II, III, IV and V, we see that they might all have been drawn in one figure (Fig. 150) for $q + p = w_{11} + w_1 + w$, therefore:

$d\,o + o\,a = d\,c + c\,b + b\,a$,

further both V and IV contain $d\,x = x_4$
" " V " I " $o\,x = y$
" " II " I " $a\,x = x_1$
" " II " III " $b\,x = x_2$
" " III " IV " $c\,x = x_3$

We know further that the respective lines are parallel with each other.

In Fig. 150 then, we have $d\,c = w_{11}$
$c\,b = w_1$
$b\,a = w$
$a\,o = p$ and
$o\,d = q$

The distance $x\,y$ of *pole* x from *load line* $d\,a$ being arbitrary, and the position of pole x the same. The figure $E\,G\,H\,I\,F\,E$ (Fig 149) has many valuable qualities. If at any point K of beam we draw a vertical line $K\,L\,M$, then $L\,M$ will represent (as compared with the other vertical lines) the proportionate amount of bending moment at K. If we measure $L\,M$ in parts of the length of $A\,D$ and measure $x\,y$ (the distance of pole, Fig. 150) in units of the load line $d\,a$, then will the product of $L\,M$ and $x\,y$ represent the actual bending moment at K. That is, if we measure $L\,M$ in inches and — (having laid out $d\,c$, $c\,b$, etc., in pounds) — measure $x\,y$ in pounds, the bending moment at K will be $= x\,y.\ L\,M$ (in pounds-inch.) Similarly at w the bending moment would be

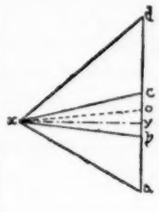


Fig. 150.

$= N\,G.\ x\,y$ (in pounds-inch.)

and at w_1 it would be $= R\,H.\ x\,y$ " " "
and at w_{11} it would be $= S\,I.\ x\,y$ " " "

measuring, in all cases, $x\,y$ in pounds and $N\,G$, $R\,H$ and $S\,I$ in inches.

Average Strain on Extreme Fibres. The area of $E\,G\,H\,I\,F\,E$, divided by the length of span in inches will give the average strain for the entire length on extreme top or bottom fibres of beam, providing the

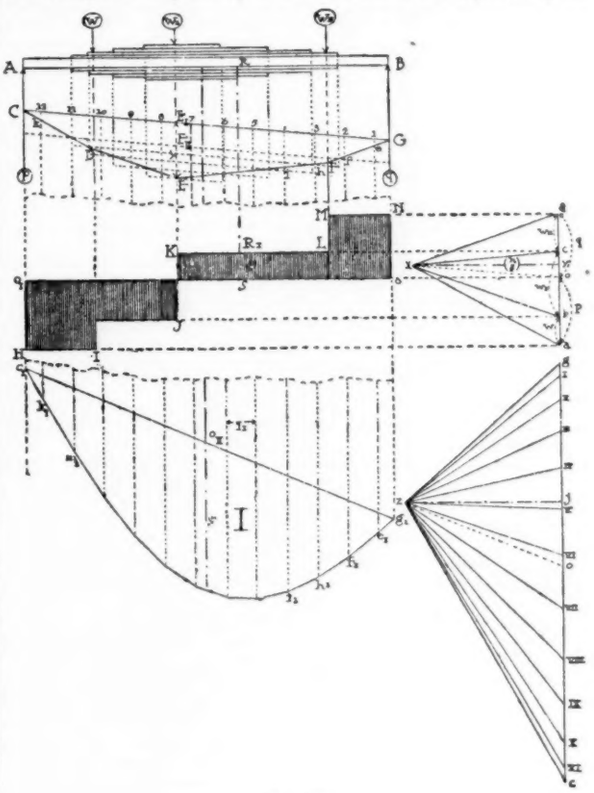


Fig. 151.

beam is of uniform cross-section throughout. The area should be figured by measuring all horizontal dimensions in inches, and all vertical dimensions in parts of the longest vertical ($S\,I$ in our case), this longest vertical being considered $= \left(\frac{c}{f}\right)$ for top, or $\left(\frac{t}{f}\right)$ for bottom fibres, or where these are practically equal $= \left(\frac{k}{f}\right)$.

The greatest bending moment on the beam will occur at the point

GLOSSARY OF SYMBOLS.—The following letters, *in all cases*, will be found to express the same meaning, *unless distinctly otherwise stated*, viz.:—

a = *area*, in square inches.
b = *breadth*, in inches.
c = constant for *ultimate resistance to compression*, in pounds, per square inch.
d = *depth*, in inches.
e = constant for *modulus of elasticity*, in pounds-inch, that is, pounds per square inch.
f = *factor-of-safety*.
g = constant for *ultimate resistance to shearing*, per square inch, across the grain.
g_1 = constant for *ultimate resistance to shearing*, per square inch, lengthwise of the grain.
h = *height*, in inches.
i = *moment of inertia*, in inches. [See Table I.]
k = *ultimate modulus of rupture*, in pounds, per square inch.
l = *length*, in inches.
m = *moment or bending moment*, in pounds-inch.
n = *constant* in Rankine's formula for compression of long pillars. [See Table I.]
o = the *centre*.
p = the *amount* of the *left-hand re-action* (or support) of beams, in pounds.
q = the *amount* of the *right-hand re-action* (or support) of beams, in pounds.
r = *moment of resistance*, in inches. [See Table I.]
s = *strain*, in pounds.
t = constant for *ultimate resistance to tension*, in pounds, per square inch.
u = *uniform load*, in pounds.
v = *stress*, in pounds.
w = *load at centre*, in pounds.
x, y and z signify *unknown quantities*, either in pounds or inches.
δ = *total deflection*, in inches.
ρ^2 = *square of the radius of gyration*, in inches. [See Table I.]
$\mathfrak{D}$ = *diameter*, in inches.
$\mathfrak{r}$ = *radius*, in inches
π = 3.14159, or, say, 3 1-7 signifies the *ratio of the circumference and diameter of a circle*.

If there are more than one of each kind, the second, third, etc., are indicated with the Roman numerals, as, for instance, a, $a_{\rm I}$, $a_{\rm II}$, $a_{\rm III}$, etc., or b, $b_{\rm I}$, $b_{\rm II}$, $b_{\rm III}$, etc.

In taking moments, or bending moments, strains, stresses, etc., to signify at what point they are taken, the letter signifying that point is added, as, for instance:—

m = moment or bending moment at *centre*.
$m_{\rm A}$ = " " " *point A*.
$m_{\rm B}$ = " " " *point B*.
$m_{\rm X}$ = " " " *point X*.
s = strain at *centre*.
$s_{\rm B}$ = " *point B*.
$s_{\rm X}$ = " *point X*.
v = stress at *centre*.
$v_{\rm D}$ = " *point D*.
$v_{\rm X}$ = " *point X*.
w = load at *centre*.
$w_{\rm A}$ = " *point A*.

[1] Continued from No. 615, page 209.

where the longest vertical can be drawn through the figure. From this figure can also be found the shearing strains and deflection of beam, as we shall see later.

Distance of Pole. If now instead of selecting arbitrarily the distance $x\,y$ of the pole from load line $d\,a$ (Fig. 150) we had made this distance equal the safe modulus of rupture of the material, or $x\,y=\left(\frac{k}{f}\right)$ — measuring $x\,y$ in pounds at same scale as the load line $d\,a$ — it stands to reason that any vertical through the Figure $E\,G\,H\,I\,F\,E$ (Fig. 149) measured in inches, will represent the required moment of resistance, for if $L\,M.\,x\,y=m$, we know from Formula (18), that $m=r.\left(\frac{k}{f}\right)$ and as we made $x\,y=\left(\frac{k}{f}\right)$, we have, inserting values in above:

$$L\,M.\left(\frac{k}{f}\right)=r.\left(\frac{k}{f}\right) \text{ or}$$

$$L\,M=r$$

Having thus shown the basis of the graphical method of analyzing transverse strains, we will now give the actual method without wasting further space on proofs.

Several Concentrated Loads. If there are three loads w, w_1 and w_{11} on a beam $A\,B$ (Fig. 151) we proceed as follows: at any convenient scale — to be known as the pounds-scale — lay off in pounds, $d\,c=w_{11}$; also $c\,b=w_1$ and $b\,a=w$. Let $A\,B=l$ measured in inches — this scale being called the inch-scale. Now select pole x at random,

Strain Diagram. but at a distance (measured with pounds-scale) $x\,y=\left(\frac{k}{f}\right)=$ the safe modulus of rupture of the material. Draw $x\,d$, $x\,c$, $x\,b$ and $x\,a$. Now begin at any point G of reaction q, draw $G\,F$ parallel $d\,x$, till it intersects vertical w_{11} at F: then from F draw $F\,E$ parallel $c\,x$ to vertical w_1; then draw $E\,D$ parallel $b\,x$ to vertical w; and then $D\,C$ parallel $a\,x$ to reaction p. From C draw $C\,G$, and through x draw $x\,o$ parallel $C\,G$.

Reactions. We now have the following results:

$o\,d=$ reaction q (measured with pounds-scale.)
$a\,o=$ " p " " " "

any *vertical* through figure $C\,D\,E\,F\,G\,C$, (measured with inch-scale) gives the amount of $r=$ required moment of resistance in inches, at point of beam where vertical is measured. The longest vertical passes through the point of greatest bending-moment in beam. Multiply any vertical (in inches) with $x\,y$ (in pounds) to obtain amount of bending-moment at point of beam through which vertical passes.

Moment of Resistance. or we should have: $r=v$ (92)

Where $r=$ the required moment of resistance, in inches, at any point of beam.

Where $v=$ the length (measured with inch-scale) of the vertical through upper figure $C\,D\,E\,F\,G\,C$ at point of beam for which r is sought.

And further:

Bending-moment. $m=v.\,x\,y$ (93)

Where $m=$ the bending moment at any point of beam in pounds-inch.

Where $v=$ the same value as in Formula (92)

Where $x\,y=$ the length, (measured with pound-scale) of distance of pole x from load line, in upper strain diagram $x\,a\,d$.

If now we draw horizontal lines through d, c, b and a; and through $o\,a$ horizontal line for horizontal axis; and continue these lines until they intersect their respective load verticals w_{11}, w_1 and w, the shaded figure $O,\,H\,I\,J\,K\,L\,M\,N\,O\,O_1$ will give the vertical shearing strain along beam. Any vertical (as R, S) drawn through this figure to horizontal axis and measured with pounds-scale, gives the amount of vertical shearing at the point of beam (R) through which vertical is drawn.

Or

Vertical Cross-shearing. $s=v_{11}$ (94)

Where $s=$ the amount of vertical shearing strain in pounds, at any point of beam.

Where $v_{11}=$ the length (measured with pounds-scale) of vertical through figure $O,\,H\,I\,J\,K\,L\,M\,N\,O\,O_1$ dropped from point of beam for which strain s is sought.

We now divide $G\,C$ into any number of *equal* parts — say twelve in our case — and begin with a half part, or

G to $1=12$ to $C=\frac{1}{24}.\,G\,C$; also
1 to $2=2$ to $3=3$ to $4=4$ to 5, etc. $=\frac{1}{12}.\,G\,C$

and make the new lower load line $g\,c$ with inch-scale so that

Deflection Diagram.

g to I = length of vertical $1\,e$
further I to II = length of vertical $2\,f$
" II " III = " " " $3\,h$
" III " IV = " " " $4\,i$, etc. until
" XII " c = " " " $12\,k$

Now select arbitrarily a pole z at any distance $z\,j$ from load line $g\,c$.

Now draw anywhere's below the beam where convenient (say I. Fig. 151) beginning at g_1 the line $g_1\,e_1$ parallel $g\,z$ till it intersects the prolongation of $l\,e$ (from above) at e_1; then draw $e_1\,f_1$ parallel I z till it intersects vertical $2\,f$ at f_1; and similarly draw $f_1\,h_1$ parallel II z; also $h_1\,i_1$ parallel III z, etc., to $m_1\,k_1$ parallel XI z and finally $k_1\,c_1$ parallel $c\,z$. The more parts (l_1) we divide the beam into, the nearer will this line $g_1\,e_1\,f_1\,m_1\,k_1\,c_1$ approach a curve. The real line to measure deflections would be a curve with the above lines as tangents to it; we need not, however, bother to draw this curve for practical work. Now draw $c_1\,g_1$ and parallel thereto $z\,o$. Divide $g_1\,c_1$ at o_{11} so that[1]: $g_1\,o_{11}:\,c_1\,o_{11}=c\,o:\,g\,o$, then will o_{11} be the point of greatest deflection along beam. This will be further proven by the fact that the greatest vertical (in lower figure I) will pass through o_{11}, if the real curve were drawn. The figure $g_1\,e_1\,f_1\,h_1\,i_1\,m_1\,k_1\,c_1\,g_1$ will measure the amount of deflection of beam at all points of beam. The deflection at any po.nt of beam being proportionate to length of its vertical through lower figure I. The *amount* of this deflection will be

Amount of Deflection, Definite Pole Distance.

$$\delta=\frac{v_1.\,l_1.\,z\,j.\left(\frac{k}{f}\right)}{e.\,i.} \qquad (95)$$

Where $\delta=$ the deflection, in inches, at any point of beam, if pole distance of upper strain diagram $(x\,y)=\left(\frac{k}{f}\right)$.

Where $v_1=$ the length of vertical, in inches, dropped from said point through lower figure I (see Fig. 151)

Where $l_1=$ the length, in inches, of each equal part 1 to 2, 2 to 3, 3 to 4, etc., into which beam was divided, [in our case $l_1=\frac{1}{12}\,l$.]

Where $i=$ the moment of inertia, of cross-section at said point, in inches.

Where $z\,j=$ the distance (measured with inch-scale) of pole z from load lines in lower strain diagram.

Where $\left(\frac{k}{f}\right)=$ the safe modulus of rupture, per square-inch, of the material.

Where $e=$ the modulus of elasticity, in pounds-inch, of the material.

If we were to so proportion the beam that the moment of resistance at each point would exactly equal the required moment of resistance as found above, we should have:[2]

Deflection varying Cross-section.

$$\delta=\frac{v_1.\,l_1.\,z\,j.\left(\frac{k}{f}\right)}{v.\,\frac{d}{2}.\,e} \qquad (96)$$

Where $\delta, v_1, z\,j, \left(\frac{k}{f}\right), e$ and l same value as in Formula (95).

Where $v=$ length of corresponding vertical in upper figure $C\,D\,E\,E\,G\,C$, (to vertical v_1 of lower Fig. I) to be measured in inches.

Where $\frac{d}{2}=$ one-half the total depth of beam, in inches. Had we not made $x\,y=\left(\frac{k}{f}\right)$, we should have

Deflection Pole Distance arbitrary.

$$\delta=\frac{v_1.\,l_1.\,z\,j.\,x\,y.}{e.\,i.} \qquad (97)$$

Where $\delta, v_1, l_1, e, z\,j$, and i same value as in Formula (95).

Where $x\,y=$ the length of pole distance from load line in upper strain diagram, measured in pounds.

The same formulæ and methods could be applied to cantilevers, but for these the arithmetical calculations are so very simple that it would be taking unnecessary trouble.

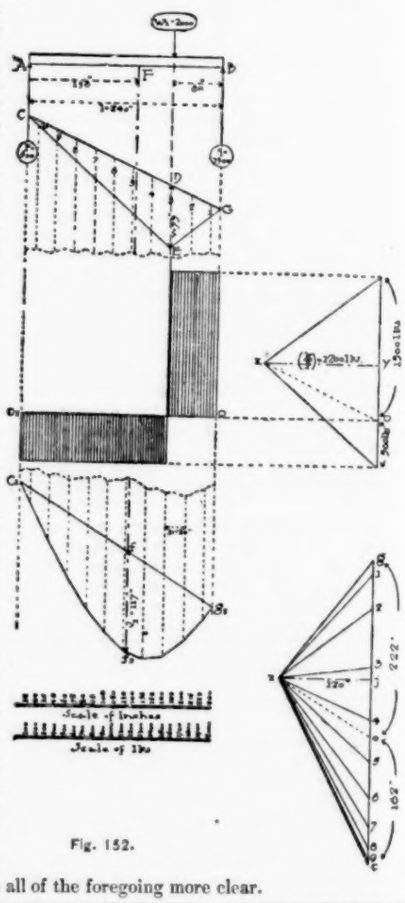


Fig. 152.

A few practical examples will make all of the foregoing more clear.

[1] This would be the greatest possible deflection. If the beam were not so proportioned, but of uniform cross-section throughout, the deflection would be less.

[2] Note that the division of the line $g_1\,o_{11}\,c_1$ is the reverse of the division of the line $g\,o\,c$.

Example I.

Single concentrated Load. *A Georgia pine girder A B of 20-foot span carries a load w_1 of 2000 pounds 5′ 0″ from right reaction B. What size should the girder be?*

We draw (Figure 152) $A\ B = 240''$ at inch-scale, and locate w_1 at 60″ to the left of B. Now draw a vertical line $b\ a = 2000$ pounds at pounds-scale. Select point x anywhere, but distant $x\ y = 1200$ pounds. (1200 pounds being $= \left(\frac{k}{f}\right)$ or the safe modulus of rupture, per square-inch, of Georgia pine). Draw $x\ b$ and $x\ a$. Draw verticals through A, w_1 and B. On vertical A begin at any point C, draw $C\ E$ parallel $x\ a$, till it intersects verticals w_1 at E; then draw $E\ G$ till it intersects vertical B at G. Draw $G\ C$ and $o\ x$ parallel to $G\ C$. We scale $o\ b$, it scales 1500 pounds, so this, is the reaction at B. We scale $a\ o$, it scales 500 pounds and this is the reaction at A. The longest vertical through $C\ E\ G$ is vertical w_1, therefore greatest bending-moment is at w_1 which we know is the case. We scale $E\ D$ at inch-scale, it scales 75 inches, therefore the (greatest) *required* moment of resistance will be at w_1 and will be Formula (92).

$$r = 75.$$

From Table I, section No. 2, we know for rectangular beams,

$$r = \frac{b.\,d^2}{6}, \text{ therefore:}$$

$$\frac{b.\,d^2}{6} = 75, \text{ or}$$

$$b.\,d^2 = 450.$$

We will suppose the girder is not braced sideways, and needs to be pretty broad; let us try $l = 5''$, we have then:

$$5.\,d^2 = 450 \text{ or}$$

$$d^2 = \frac{450}{5} = 90 \text{ and}$$

$$d = 9,\ 5'' \text{ or the girder}$$

would have to be 5″ x 9½″ or say 5″ x 10″. The bending-moment at w_1 is, of course, Formula (93) $= E\ D.\ x\ y = 75.1200 = 90000$ (pounds-inch).

Had we calculated arithmetically, we should have had, Formulæ (14) and (15):

$$\text{reaction } A = \frac{60}{240}.\ 2000 = 500 \text{ pounds.}$$

$$\text{“ } B = \frac{180}{240}.\ 2000 = 1500 \text{ pounds.}$$

Bending moment at w_1 would be (right side) Formulæ (23) and (24). $m_{w_1} = 1500.60 - 0.2000 = 90000$ (pounds-inch) or check (left) side $m_{w_1} = 500.180 - 0.2000 = 90000$ (pounds-inch.) Therefore required moment of resistance, Formula (18)

$$r = \frac{90000}{1200} = 75.$$

or same result as graphically.

By drawing the horizontals from b between verticals B and w_1; from a between verticals A and w_1; and from o between verticals A and B we get the etched figure for measuring vertical shearing strains. We see at a glance that the shearing to the right of load is equal to the right reaction, and is constant at all points of right side of beam; while on the left side of load it is equal to the left reaction, and is constant at all points of the left side of beam. And this we know is the case. We need not bother with shearing, however, for we can readily see there is no danger. For even immediately to the right of the load, the weakest point in our case, we know that one-half of the fibres of cross-section are not strained at all, or we should have one-half of area or $\frac{5.10}{2} = 25$ square-inches to resist 1500 pounds of shearing, or $\frac{1500}{25} = 60$ pounds per square-inch, while the safe resistance, per square-inch, of Georgia pine to shearing across the grain is (Table IV) $\left(\frac{g}{f}\right) = 570$ pounds.

There is, however, some danger of excessive deflection; we draw, therefore, the figure c, f, g, by dividing the beam into ten equal parts, beginning and ending with half parts at the reaction, (each whole part being 24″ long, or $l_1 = \frac{240}{10} = 24''$)

We draw the verticals through these parts and get their lengths through figure $C\ E\ G$. These lengths we carry down in their proper succession on the load line $g\ j\ c$ of the lower strain diagram, beginning at the top with the right vertical 1, putting immediately under this the length of second vertical 2, then 3 and so on till $g\ c$ = sum of lengths of all ten verticals through $C\ E\ G$. We now select z at random (in our case 120 inches from load line or $z\ j = 120''$). We now draw lines from z to g I, II, III, etc., to c. Construct figure g, f, c, by beginning at g, drawing line parallel to $z\ g$ until it intersects prolongation of first vertical 1; then line parallel to z I till it intersects prolongation of second vertical 2, etc. We now draw $z\ o$ parallel c, g. We scale $g\ o$ and find it scales 222″, also $c\ o$ which scales 162″; we divide c, g, at f, so that

$$c, f : f\ g_1 = 222 : 162.$$

Carrying vertical $f\ f_1$ through figure we find it scales $(v_1) = 117''$ continuing $f\ f_1$ up to beam it gives us point F as the point of greatest deflection, we find $A\ F$ scales 138″. Had we used Formula (43) we should have located F at a distance from A or $A\ F = \sqrt{\frac{240^2 - 60^2}{3}} = 134,\ 17''$. So that we have a sufficiently accurate result.

For the amount of deflection at F we use Formula (95); we know that (Table I, Section No. 2) $i = \frac{b.\,d^3}{12} = \frac{5.\,10^3}{12} = 417$, further for Georgia pine $\left(\frac{k}{f}\right) = 1200$ pounds.

$$e = 1200000 \text{ (inch-pounds.)}$$
$$l_1 = 24''$$
$$v_1 = f f_1 = 117''$$
$$z\,j = 120'', \text{ therefore:}$$
$$\delta = \frac{117.\,24.\,120.\,1200}{1200000 \quad .417}$$
$$= 0{,}808''$$

Had we calculated the deflection by Formula (41) we should have had:

remembering that $m = 180''$ and $n = 60''$ and $l + n = 240 + 60 = 300''$

$$\delta = \frac{2000.\,180.\,60.\,300}{9.\,240.\,1200000.\,417} \sqrt{\frac{180.\,300}{3}}$$
$$= 0{,}803''$$

Which proves the accuracy of the graphical method.

For a beam of 20 feet span the deflection not to crack plastering should not exceed, Formula (28).

$$\delta = 20.\,0{,}03 = 0{,}6''$$

Therefore, if our beam supports a plastered ceiling, it must be redesigned to be *stiffer*. Either made deeper, in which case it can be

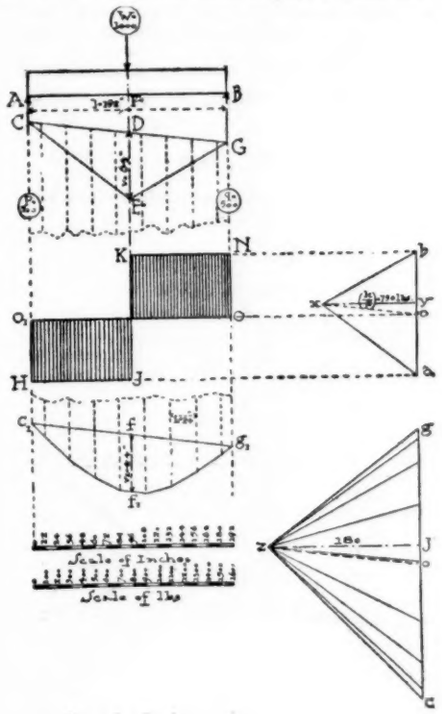


Fig. 153.

thinner, if braced sideways, or it can be thickened sufficiently to reduce the deflection, see Formula (31).

Example II.

Single centre load. *A hemlock girder A B (Fig. 153) of 16-foot span, carries a centre load w of 1000 pounds. What size should the girder be?*

We make $A\ B = 192''$ at inch scale; locate w at its centre F; make $b\ a$ at any scale — (pounds-scale) — equal 1000 pounds. Select pole x distant, $x\ y = 750$ pounds, from load line $b\ a$, (as 750 pounds $= \left(\frac{k}{f}\right)$ the safe modulus of rupture per square inch of hemlock). Draw $x\ b$ and $x\ a$. Begin at G, draw $G\ E$ parallel $b\ x$ to vertical through load, and then draw $E\ C$ parallel $a\ x$. Draw $C\ G$ and then $x\ o$ parallel $C\ G$, we find that o bisects $b\ a$ or $a\ o = o\ b = 500$ pounds. Each reaction is therefore one-half of the load; this we know is the case. Greatest line through $C\ G\ E$ we find is at $D\ E$, so that greatest bending-moment is at load; this we know is the case. $D\ E$ scales 64″ at inch-scale, therefore the required moment of resistance for the beam is, Formula (92):

$$r = 64.$$

and the greatest bending-moment at load, Formula (93):

$$m_w = 64.\ x\ y = 64.750$$
$$= 48000$$

Had we calculated arithmetically we should have obtained the same results, for Formula (22)

$$m_w = \frac{1000.\ 192}{4} = 48000$$

and Formula (18):

$$r = \frac{48000}{750} = 64$$

Now from Table I, Section No. 2, we know that for rectangular sections:

$$r = \frac{b.d^2}{6} \text{ or}$$

$$b.d^2 = 64.6 = 384.$$

If we assume the beam as 4″ thick, we have then:

$$4.\ d^2 = 384.$$

$$d^2 = \frac{384}{4} = 96 \text{ or}$$

$$d = \sqrt{96} = 9{,}8'' \text{ or we will make the beam } 4'' \times 10''.$$

We draw the figure $O_1\ H\ J\ K\ N\ O$ for shearing and find it is constant throughout the whole length of beam and equal to length $O_1\ H$ or $N\ O$ measured at pounds scale, or 500 pounds. This is so small we need not bother with it.

To obtain the deflection diagram we divide $G\ C$ into eight equal parts, each part $l = \frac{192}{8} = 24''$ and begin at each end with half parts, drawing the eight verticals through $C\ E\ G$.

We lay off their exact lengths in proper succession on the lower load line $g\ c$, beginning at the top with the right vertical. Select pole z at random, in this case distant from load line $z\ j = 180''$. We now draw the figure $c_1\ g_1\ f_1$ and find greatest deflection is at its centre $f\ f_1$; for $z\ o$ parallel $c_1\ g_1$ bisects $g\ c$. We scale $f\ f_1$ at inch scale $= 44''$, therefore greatest deflection of beam at centre, Formula (95), remembering that (Table I, Section No. 2) $i = \frac{4.10^3}{12} = 333$ and (Table IV) $e = 800000$

$$\delta = \frac{44.\ 24.\ 180.\ 750}{800000\ .333} = 0{,}535''$$

Had we calculated the deflection arithmetically from Formula (40)

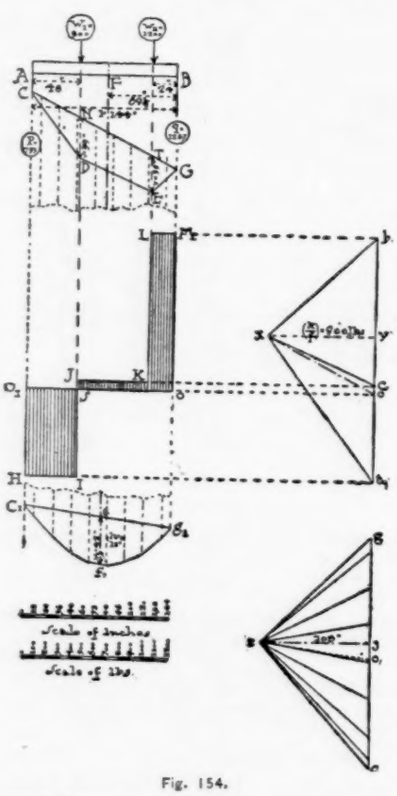


Fig. 154.

we should have had:

$$\delta = \frac{1}{48} \cdot \frac{1000.\ 192^3}{800000.\ 333} = 0{,}548''$$

or practically the same result.

If the beam supported plastered work the deflection should not exceed, Formula (28)

$$\delta = 16.\ 0{,}03 = 0{,}48''$$

Still, unless we were very particular, the beam could be passed as practically stiff enough.

Example III.

Two concentrated loads. *A white pine beam $A\ B$ Fig. 154, of 12-foot span carries two loads, one $w_1 = 800$ pounds, four feet from left support, the other $w_{11} = 1200$ pounds, two feet from right support. What size should the beam be?*

Make $A\ B$ at inch scale $= 144$ inches, locate w_1 so that $A\ w_1 = 48''$, and w_{11} so that $B\ w_{11} = 24''$. At any (pounds scale) make $b\ c = 1200$ pounds and $c\ a = 800$ pounds. Select pole x distant from $b\ a$; $x\ y = 900$ pounds, the safe modulus of rupture per square inch of white pine; draw $x\ b$, $x\ c$ and $x\ a$. Construct $C\ D\ E\ G$ parallel to these lines. Draw $C\ G$, and parallel to same $x\ o$, then will $a\ o = 733$ pounds be reaction at A, and $o\ b = 1267$ pounds be reaction at B. We scale vertical $D\ N$ at $w_1 = 39''$ and $T\ E$ at $w_{11} = 35''$, therefore greatest bending-moment is at w_1 and Formula (93)

$$m_{w_1} = 39.\ 900 = 35100$$

Further, the required moment of resistance at w_1 Formula (92) will be:

$$r = D\ N = 39.$$

Now from Table I, Section No. 2,

$$r = \frac{b.d^2}{6}, \text{ or}$$

$$b.d^2 = 6.39 = 234.$$

Now if $b = 3''$ we should have

$$d^2 = \frac{234}{3} = 78 \text{ and}$$

$$d = \sqrt{78} = \text{say } 9'', \text{ or the beam would need to be } 3'' \times 9''.$$

We should have obtained practically the same results arithmetically, for: Formulæ (16) and (17):

$$\text{Reaction at } A = \frac{800.96}{144} + \frac{1200.24}{144} = 733.$$

$$\text{Reaction at } B = \frac{800.48}{144} + \frac{1200.120}{144} = 1267$$

check: $A + B = w_1 + w_{11} = 800 + 1200 = 2000$ pounds and $733 + 1267 = 2000$ pounds.

Beginning at B we have to pass over load w_{11} (1200 pounds) and on to w_1, before passing amount of reaction B (1267 pounds) therefore greatest bending-moment at w_1. We know from Formula (24) it would be:

$$m_{w_1} = 1267.96 - 72.1200 = 35232$$

and check from Formula (23)

$$m_{w_1} = 733.48 - 0.800 = 35184$$

being near enough for practical purposes. From Formula (18) we should have had:

$$r = \frac{35184}{900} = 39{,}09$$

We now draw the shearing diagram $O_1\ H\ I\ J\ K\ L\ M\ O$, as shown in Figure 154, and find the amount of shearing

from A to $w_1 = O_1\ H =$ 733 pounds,
from w_1 to $w_{11} = J\ S =$ 67 pounds,
from w_{11} to $B = M\ O = 1267$ pounds.

We can overlook it, for even at the weakest point of beam for resisting cross-shearing we have half the area, or $\frac{3.9}{2} = 13\frac{1}{2}$ square inches.

White pine will safely resist 250 pounds per square inch in cross-shearing (Table IV) or the beam would resist.

$13\frac{1}{2} . 250 = 3375$ pounds at its weakest point for cross-shearing, (viz.: at w_1) and twice as much at the reactions.

To find the deflection we divide $G\ C$ into eight equal parts, beginning with half parts (or $l_1 = \frac{144}{8} = 18''$) and draw the verticals through $C\ D\ E\ G$. We now make the lower load line $g\ c$ equal the sum of these verticals, beginning at the top with the right vertical.

Select z distant from $g\ c$ (the load line) $z\ j = 108''$. Draw $z\ g$, $z\ c$, etc., and construct $g_1\ c_1\ f_1$ as before.

We draw $z\ o$ parallel $c_1\ g_1$. Now $g\ o$ measures 116 inches and $o\ c$ 108 inches, therefore divide $c_1\ g_1$ at f so that:

$$c_1 f : f\ g_1 = 116 : 108$$

Carrying the vertical $f\ f_1$ up to point F of beam, we find the point of greatest deflection F, where

$$B\ F = 69\tfrac{1}{2}'' \text{ and } A\ F = 74\tfrac{1}{2}''$$

We find $f\ f_1$ scales 42″, remembering that (Table I, Section No. 2) $i = \frac{3.9^3}{12} = 182$, and that for white pine Table IV $e = 850000$ pounds we have Formula (95):

$$\delta = \frac{42.\ 18.\ 108.\ 900}{850000\ .182} = 0{,}475''$$

Had we attempted to get this result arithmetically by inserting the values in Formula (41) (and remembering that n is always the nearer support, or in our case respectively 48″ and 24″, while m respectively 96″ and 120″) we should realize the advantage of the graphical method, for:

$$\delta = \frac{800.\ 96.\ 48.\ (144+48).\sqrt{\frac{96.\ (144+48)}{3}} + 1200.\ 96.\ 48.\ (144+24).\sqrt{\frac{120.\ (144+24)}{3}}}{9.\ 144.\ 850000.\ 182}$$

If we figure out the above tedious formula we should have

$$\delta = 0{,}422''$$

or practically the same result as we obtained graphically.

The safe deflection, were the beam to carry plastering, should not exceed Formula (28)

$$\delta = 12.\,0,03 = 0{,}36''$$

Our beam is therefore not nearly stiff enough, and we must make it thicker; or else if we wish to save material, we will make it thinner, but deeper; and then brace it sideways, see Formula (31).

Example IV.

Five Concentrated Loads. *A spruce girder A B of 18-foot span carries five loads, as shown in Figure 155. What size should the girder be?*

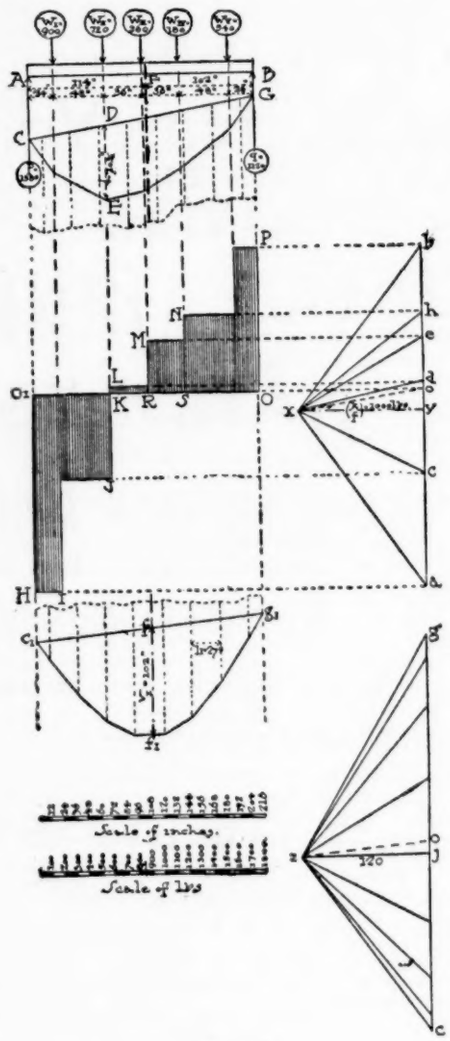


Fig. 155.

We draw $A\,B = 216''$ (inch scale); further

$b\,a = 2700$ pounds (sum of loads at pounds scale); make
$b\,h = w_v = 540$ pounds,
$h\,e = w_{iv} = 180$ pounds,
$e\,d = w_{iii} = 360$ pounds,
$d\,c = w_{ii} = 720$ pounds, and
$c\,a = w_i = 900$ pounds.

Select x distant $x\,y = 1000$ pounds from $b\,a$, (as $1000 = \left(\frac{k}{f}\right)$ for spruce, see Table IV). Draw $x\,b$, $x\,h$, $x\,e$, etc., and figure $C\,D\,G$. Draw $x\,o$ parallel $C\,G$; it divides load line as follows:

$a\,o = 1580$ pounds or reaction at A.
$o\,b = 1120$ pounds or reaction at B.

We find longest vertical through $C\,D\,G$, is at load w_{ii}, therefore greatest bending-moment on beam at w_{ii}; now $D\,E$ scales $70\frac{1}{2}''$, therefore Formula (93):

$$m_{w_{ii}} = 70\tfrac{1}{2}.\,1000 = 70500$$

and Formula (92)

$$r = 70,\,5$$

From Table I, Section No. 2,

$$r = \frac{b.d^2}{6} = 70,\,5 \text{ and if } b = 5, \text{ we have}$$

$5.\,d^2 = 6.\,70,\,5$ or
$d^2 = 84,\,6$, and
$d = \sqrt{84,\,6} = 9{,}2''$ or say $10''$ which is the nearest size larger than $9{,}2''$, and of course wooden beams are never ordered to fractions of inches.

Had we worked arithmetically we should have had practically the same results.

From Formulæ (16) and (17) we should have had:
reaction at $A = 1580$ pounds,
reaction at $B = 1120$ pounds.

From rule for finding greatest bending-moment we should have located it at w_{ii} and then had Formula (23)

$$m_{w_{ii}} = 1580.\,72 - 48.900 = 70560$$

and from Formula (18)

$$r = \frac{70560}{1000} = 70,\,56.$$

We now draw the shearing diagram $O_1\,H\,I\,J\,K\,L\,M\,N\,P\,O$ and find as follows:

Cross-shearing A to $w_i = H\,O = 1580$ pounds.
Cross-shearing w_i to $w_{ii} = J\,K = 680$ pounds.
Cross-shearing w_{ii} to $w_{iii} = K\,L = 40$ pounds.
Cross-shearing w_{iii} to $w_{iv} = M\,R = 400$ pounds.
Cross-shearing w_{iv} to $w_v = N\,S = 580$ pounds.
Cross-shearing w_v to $B = P\,O = 1120$ pounds.

We need not bother with it, therefore. For deflection we now divide $C\,G$ again into eight equal parts, (or $l_1 = \frac{216}{8} = 27''$) beginning with half parts at C and G. We now make lower load lines $g\,c =$ the sum of the eight verticals, putting the right vertical at the top from g down. We select pole z at a distance $z\,j = 120''$ from $g\,c$ and draw $z\,g$, $z\,c$, etc. We construct figure $g_1 f_1 c_1$ and draw $z\,o$ parallel to $c_1\,g_1$. We now divide $c_1\,g_1$ at f, so that

$g_1 f : f\,c_1 = c\,o : o\,g$, carrying $f f_1$ up to beam, we have the point F, distant $102''$ from B, and $114''$ from A, which is the point of greatest deflection. We find that $f\,f_1$ scales $102''$, remembering that $e = 850000$ for spruce (Table IV), and that $i = \frac{5.10^3}{12} = 417$ (See Table I, Section No. 2) we have, Formula (95).

$$\delta = \frac{102.\,27.\,120.\,1000}{850000.\,417} = 0{,}93''$$

This would be too much for plastering, for if the girder supported plastering, the deflection should not exceed Formula (28)

$$\delta = 18.\,0,\,03 = 0{,}54''$$

We must therefore deepen the beam very materially.

We use Formula (31),

$$x = \frac{1}{b.d^3}$$

In our case it would be

$$x = \frac{1}{5.10^3} = \frac{1}{5000} = 0{,}0002$$

Supposing we were to make the beam $4'' \times 12''$, then we should have

$$x = \frac{1}{4.12^3} = 0,\,000\,144$$

The deflection of the latter, then, would be

$\delta : 0,\,93 = 0,\,000144 : 0,\,0002$ or

$$\delta = \frac{0,\,93.\,0,000144}{0,0002} = 0{,}67'' \text{ still too much deflection.}$$

Were we to make the beam $3'' \times 14''$, we should have:

$$x = \frac{1}{3.14^3} = 0{,}0001215$$

The corresponding deflection for this beam would be:

$\delta : 0,\,93 = 0{,}0001215 : 0{,}0002$ or

$$\delta = \frac{0,\,93.\,0,0001215}{0,0002} = 0{,}565''$$

or just about what would be required in the way of stiffness.

Had we used Formula (95) we should have had, remembering that now

$$i = \frac{3.14^3}{12} = 686$$

$$\delta = \frac{102.\,27.\,120.\,1000}{850000.\,686} = 0{,}568''$$

showing that we have made no mistake in applying Formula (31). If we have any doubts as to whether a $3'' \times 14''$ stick is as strong as a $5'' \times 10''$ we use Formula (30) and have for the former

$$x = 3.\,14^2 = 588$$

while for the latter

$$x = 5.\,10^2 = 500,$$ so that the $3'' \times 14''$ stick is actually much stronger, as well as much stiffer than the $5'' \times 10''$. It is, however, a very thin beam, and would be apt to warp or twist, unless braced sideways about every five feet of its length.

To attempt to get the deflection of the girder arithmetically would be a very tedious operation. It could be done, however, by inserting in Formula (41) the different values for n and m, remembering every time to make n the distance from each weight to the *nearer* support to respective weight, and m the distance from same weight to the further support.

LOUIS DECOPPET BERG.

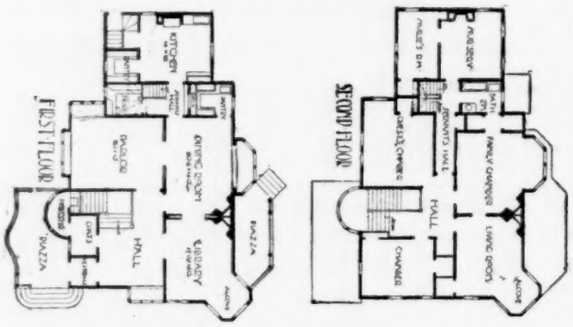
[To be continued.]

ILLUSTRATIONS

[Contributors are requested to send with their drawings full and adequate descriptions of the buildings, including a statement of cost.]

HOUSE FOR GORHAM THURBER, ESQ., PROVIDENCE, R. I. MR. E. I. NICKERSON, ARCHITECT, PROVIDENCE, R. I.

[Gelatine print, issued only with the Imperial Edition.]



DESIGN FOR CLUB-HOUSE OF THE NEW YORK ATHLETIC CLUB, SEDGEMERE, L. I. MR. GEORGE MARTIN HUSS, ARCHITECT, NEW YORK, N. Y.

FIRST METHODIST EPISCOPAL CHURCH, WILKES-BARRE, PA. MR. BRUCE PRICE, ARCHITECT, NEW YORK, N. Y.

STATE NORMAL SCHOOL, MOORHEAD, WIS. MR. J. WALTER STEVENS, ARCHITECT, MINNEAPOLIS, MINN.

MELROSE HALL, OAK LANE, PA. MR. HARRISON ALLBRIGHT, ARCHITECT, PHILADELPHIA, PA.

"SHINGLE-NOOK": HOUSE FOR BRANDER MATTHEWS, ESQ., NARRAGANSETT PIER, R. I. MR. G. A. FREEMAN, JR., ARCHITECT, NEW YORK, N. Y.

UNITED STATES GOVERNMENT BUILDING PRACTICE.[1]—XI.

CARPENTER WORK.

Arabian Tomb after L'Architecture.

UNDER this trade is generally included the entire construction of frame houses, the floor-joists, stud-partitions, roof-trusses, framing, etc., of stone and brick buildings, wood fences, shingles and roof trimmings when made of wood. Dressed flooring, construction of stairs, glazed screens, counters, wainscotting, doors and windows, are specified under the head of joiner-work.

Marine-hospital wards, quarantine stations and such other temporary buildings which are required by the Government and expected to last only a few years, are built of wood, that is, frame buildings; all other buildings, custom-houses, court-houses and post-offices, are built of stone or brick, and the construction of floors and roof made of iron or wood, frequently a combination of the two materials.

It is generally the custom to make the first floor of iron even when the other floors and roof are wood, except when the appropriation is very small for the size of the building, in which case the first floor is made of wood. A great many of the cheaper grade of buildings are of this character. Sometimes the floor immediately over the boiler-room for the heating apparatus is constructed of iron and the remainder of the first floor of wood.

The kind of lumber is that generally used for framing in the vicinity where the building is erected, hard yellow pine being the most used. Georgia and Florida pine is considered of a high quality and is generally preferred; pine from Maine, Michigan and Arkansas is also much used, white oak in some localities, and fir and redwood on the Pacific Slope.

SPECIFICATION.

All the lumber to be best quality pine or other approved suitable wood, thoroughly seasoned, straight-grained, free from sap, shakes and large or loose knots and to be square-edged, true and out of wind. All floor and ceiling joists, headers, trimmers, etc., to be of dimensions and located as shown and noted on the drawings.

[1] Continued from page 212, No. 645.

TABLE FOR SIZES OF WOOD FLOOR JOISTS.

Length. ft.	Size. in.	Space. in.	Load 125 lbs., per □′. lbs.	Capacity Factor 10. lbs.
10	2 x 10	16	1666	2222
11	2 x 10	16	1832	2020
12	2 x 10	16	2000	1852
12	2 x 12	16	2000	2666
13	2 x 12	16	2166	2461
14	2 x 12	16	2333	2285
14	3 x 12	16	2333	3428
15	3 x 12	16	2500	3200
16	3 x 12	16	2666	3000
17	3 x 12	16	2832	2823
18	3 x 12	12	2250	2666
18	3 x 14	16	3000	3630
19	3 x 12	12	2375	2526
19	3 x 14	16	3166	3438
20	3 x 12	12	2500	2400
20	3 x 14	16	3333	3264
21	3 x 14	12	2625	3110
22	3 x 14	12	2750	2970
23	3 x 14	12	2875	2840

The ends of joists to have 6″ bearings, cut to splay 3″ in their depths and to be cross-bridged in rows 5′ 0″ apart with 1½″ x 3″ stuff nailed with two nails at each end, and about every fifth joist of upper floors to be anchored to the walls with ¼″ x 2″ wrought-iron anchors turned up and forked as per sketch (Figure 41), and the joists on interior walls on line of anchored joists to be properly tied with ¼″ x 2″ iron straps, forming a continuous tie across the building. The joists to be cut to a camber of ¾″ in every 12′ 0″ of span and to be sized to a uniform depth and crown. Levelling up of joists to be made under their entire bearing with stone, slate or bricks; no wood blocks will be allowed.

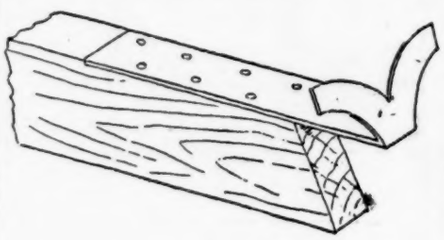


Fig. 41.

All framing to be as shown and executed in the best and most workmanlike manner, with all necessary bolts, plates, rods, angle-irons, stirrups, etc., securely nailed and bolted to joists and trimmers. All tail-beams bearing on trimmers to be framed with tenons, as shown by sketch (Figure 42), and the built headers to be well spiked together and bolted if more than two joists are used. All headers to be hung in wrought-iron stirrups ⅜″ x 2″ and bolted where necessary with ¾″ diameter bolts. No timber to be framed closer than 1″ to chimney or hot-air flue.

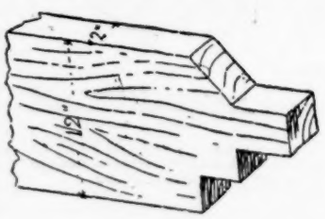


Fig. 42.

Where drawings do not show the sizes of framing timbers, the joists to be framed with double trimmers and trimmer-headers at stairs, chimneys, etc. Double joists to be placed under all stud-partitions and to be well spiked together.

For carrying terra-cotta plates on which floor-tiling is to be laid, 1″ x 2″ cleats to be nailed to each side of joists.

All floor-joists (except for floors where marble tiling is to be laid) and ceiling-joists to be covered with square-edged boards 1″ thick and not over 8″ wide, dressed one side to a uniform thickness, to be close jointed and nailed at each bearing at right angles to joists with two nails; on top of this rough or under flooring best quality tarred building-paper is to be laid, well tacked down, on which is to be laid the dressed, tongued-and-grooved flooring.

The stud-partitions, where shown on drawings and where required, to be constructed with 2″ x 4″ studs (sometimes 3″ x 6″) set with narrow edge in face of partition, spaced 16″ from centres, to have a capping and sill where not resting on or located parallel with floor-joists, of same size as studs, and to have one row of diagonal bridging 5′ 0″ above floor. All openings to be double studded and trussed, and all studding, sill, cap and bridging to be securely nailed together.

All ceilings to be cross-furred with 1″ x 2″ stuff spaced 12″ on centres securely nailed, forming a plain level ceiling.

Furring against exterior walls to prevent dampness when made of wood (this is seldom done and should be avoided if possible), to be 2″ x 2″ stuff spaced 12″ to 16″ on centres, securely spiked into joints of the brickwork or to wood pieces built in the brickwork for the purpose.

Furring for cornices, architraves, arches, etc., to be generally 2″ x 2″ lumber, spaced 12″ to 16″ on centres securely spiked to supports, the profiles to be closely followed, allowing ¾″ for lath and plaster.

Roof. — The roof generally, including trusses, wall-plates, purlins, rafters, hips, valleys, ridges, collars, ceiling-beams, framing around chimneys, scuttles, dormers, etc., with the necessary stone or cast-iron bearing-plates, iron anchors, tie and tension rods, straps, stirrups, bolts, etc., to be framed of the dimensions shown, closely cut and fitted and substantially nailed, spiked and secured in place.

Trusses. — The trusses to have bearing-plates of stone or iron or to rest on the wall-plates, so as to distribute the weight properly on the brickwork; the feet of trusses to be anchored to walls by iron rods ¾″ diameter 3′ 0″ long, built in walls, with gib-plates 8″ x 4″ x ½″ on ends. For wood-trusses the rafters, struts and lower chord or boom are made of wood; all tie and tension rods, king-rods, etc., are made of wrought-iron; all connections to be with mortises and tenons securely pinned or may be made with iron shoes or straps at feet, iron saddle for king-rod at apex, angle-irons, fish-plates, etc., all securely bolted with the necessary wood blocking. All tension-rods to have sleeve-nuts for tightening.

Purlins. — The purlins for carrying the jack-rafters should rest on top of the principal or truss rafters and secured thereto with angle-irons, straps and bolts. Where necessary for the jack-rafters to be on the same plane with the principals, the purlins may be hung from the principals by wrought-iron straps.

Wall-Plates. — The wall-plates on which the jack-rafters are to rest are generally made 3″ x 8″ or 2″ x 12″, halved at joints and corners, well spiked and anchored every 6′ 0″ with ¾″ rods about 3′ 0″ long with gib-plate (or 6″ bent end) at bottom built in brickwork, and to have large washer with nut above wall-plate; the hip, valley and jack rafters to be securely spiked to wall plate, purlins and ridges and to each other. Where the span is small and no special trusses are required, the rafters to have collar-ties 2″ x 6″ to 2″ x 10″ spiked to sides which may form ceiling-joists to attic.

The hips, ridges and valley-rafters should have from 1½ to 2 times the area in cross section of the jack-rafters, which vary in size from 2″ x 8″ to 3″ x 12″, spaced generally 2′ 0″ on centres.

Dormers. — Openings to be left for dormers where required and the dormers to be framed with 2″ x 4″ scantling and 2″ x 4″ or 2″ x 6″ rafters, the spacing of both to be 16″ on centres.

The roof framing to be doubled at chimneys and kept 2″ away from the same. Properly-shaped wood blocks to be nailed to hips and ridges for securing the ornamental metalwork to.

Boarding. — The entire roof and the roofs and sides of dormers, cupolas, towers, etc., to be covered with square-edged, rough boarding 1″ thick and not over 8″ wide, close-jointed and nailed to each bearing, and all the boarding to be covered with a layer of fibre or resin-sized building-paper well lapped and tacked down.

Skylights, scuttles and ventilators generally to be constructed of 1½″ or 2″ lumber, substantially secured to roof framing, to have a curb not less than 4″ high and made ready to receive the glazed sash of skylight and the galvanized-iron ventilator. The scuttle to have a cover framed together and covered with IXX charcoal tin or fourteen-ounce copper, to be hung with strong wrought-iron hinges and fastened with hasp-staple and padlock with chain.

Mill Construction, which is now frequently met with in this country in mills, warehouses, office-buildings, etc., has never been adopted in Government buildings for floors, but in a few instances roofs have been constructed on this principle, which consists in framing the trusses, rafters, purlins, hips, ridges, etc., in the same manner as heretofore mentioned, but the timbers are placed much farther apart and are made correspondingly large in order to bear the heavier loads of greater surfaces, the theory being to make all the timbers large so that in case of fire they will be much longer in burning than if small timbers were used and thus allow a longer time for putting out the fire. When mill construction is used, the roof-boarding is generally made 2″ and sometimes 3″ thick.

Flag-pole. — Trimmers for seat for flag-pole to be framed in attic-floor where shown, to be blocked apart and strongly nailed, the foot of pole to rest in cast-iron shoe ⅞″ metal which must be substantially bolted to trimmers, the collar at roof-line to be wrought-iron ½″ x 3″ of the required length and fastened to rafters.

The flag-pole to be pine or spruce, straight-grained, and free from knots, sap and shakes; 8″ diameter at the butt, 4″ at top and 25′ 0″ high above the roof. The top to be banded with a wrought-iron collar, and to have a 10″ diameter copper-ball gilded with XXX gold-leaf mounted on a wrought-iron rod. The pole to be furnished with two lignum vitæ sheaves and two galvanized iron halyard cleats. Two sets of best hemp halyards to be rove before raising. The pole to have two coats of linseed oil and one coat of spar varnish.

Balloon-framing. — Balloon-framing consists of a sill on top of which the studs are set and secured, the capping or plate on top of studs, the ribbon or timber for carrying the intermediate floors, the bracing at angles and framing of openings.

The sill where resting on a wall or underpinning to be made 4″ x 6″ or 4″ x 8″, to be halved at connections and corners, and securely spiked; where not resting on a continuous wall, but on piers, it must be made larger and calculated in same manner as girders.

The studs to be 3″ x 4″ or 3″ x 6″, with a post of double the size at corners, to be doubled at all openings and firmly nailed to sills and to plates, each angle to be thoroughly braced on both sides at top to plate and at bottom to sill, with braces of same size as studs; the studs to be in one piece up to plate carrying the rafters, to be spaced 16″ on centres and to be trussed over openings where necessary, and to have one row of diagonal bracing 5′ 0″ above floor.

The plate generally to be the same size as the studs, securely spiked on top of studs and halved at connections and corners, and well spiked.

The ribbon for carrying intermediate floors to be 1½″ or 2″ x 6,″ let into studs with about ¼″ projection and securely spiked.

The framing of floors, rafters, etc., to be as heretofore described, except that the floor-joists wherever coming against studs to be securely nailed thereto and toe-nailed to sill, ribbon or plate where not coming against studs; the rafters to be spiked to plate.

The entire sides of studding to be covered with 1″ thick boards not over 8″ wide, nailed to each stud diagonally laid, this to be covered with tarred or resin-sized building paper, and over this the dressed lapped-siding to be nailed.

All the trimmings, cornices, eave-boards, gutters, door and window trimmings to be of white-pine worked to sizes, mouldings, etc., shown and securely nailed in place.

The ends of rafters may project beyond eaves to support the cornices, or where necessary lookouts to be nailed to plate and to rafters for carrying the cornices and gutters.

The lapped-siding is generally ⅞″ thick, dressed, moulded and rabbeted, about 4″ wide, nailed on horizontally, and butting squarely against all casings or trimmings of openings and against angle boards, which should be from 4″ to 6″ wide.

Shingles. — Shingles are generally used to cover the roofs of frame buildings where cost is essential, as they are usually cheaper than good tin. They are made of pine sawed, also of cedar and chestnut shaved, but the best in the Eastern markets are the shaved cypress shingles about 6″ to 7″ wide and 18″ to 24″ long; they should be nailed at waist with two shingle nails showing 4″ to 6″ to the weather, and be closely cut at hips and valleys, and have double courses at eaves and ridges. Red-wood shingles are used almost entirely on the Pacific coast, they are also being used in the East.

Fences. — Wood fences are frequently constructed on the rear and sides of lots around Government buildings. The posts to be locust or cedar 6″ to 8″ in diameter, generally dressed above ground and from 3′ to 4′ 0″ in the ground, the portion in ground to be tarred, they are to be spaced from 8′ to 10′ apart. The rails to be 3″ x 4″ dressed hard pine, let into posts 2″ and securely spiked: frequently the top rail is laid flatwise on top of post and spiked thereto, and the post bevelled off back of the rail.

When the fence is made of close boards, the boarding to be ⅞″ thick, 3″ to 3½″ wide, dressed, matched and beaded, set perpendicularly and nailed with two nails to each rail, to have a base board at bottom 10″ to 12″ high, nailed to posts and a grooved cap to be let over the boarding and nailed to same.

Where pickets are used they are to be hard pine or oak ⅞″ thick, 3″ wide and set 3″ apart, securely nailed to each rail.

The entire wood fence to be painted three coats of lead and oil paint on both sides; the finishing tint to be approved.

MEASUREMENT.

All wood-framing work, floor-joists, studding, sills, wall-plates, roof-truss timbers and rafters are measured by the foot board measure [board measure = 1 square foot 1″ thick]; in taking the lengths for such timber they should be taken to an even number of feet (*i. e.*, 12′, 14′, 16′ and so on), because unless specially ordered all framing lumber is sawed and kept in stock in even foot-lengths, and when a piece of timber is of an odd length the next above even foot must be taken to get the piece out and hence the waste.

Rough-boarding for siding, under flooring, roof-boarding, etc., is measured net per foot board measure, and builders generally allow ⅛ for wastage.

Dressed or lapped-siding is measured per square foot, specified thickness, and ¼ is generally allowed for wastage.

White-pine trimmings, cornices, mouldings, etc., are generally estimated by the piece or lineal foot of moulding.

Shingles are generally estimated by the thousand, sometimes per square. Fences are estimated per lineal foot, giving description, and flag-poles, per piece.

The allowance for wastage is generally followed by builders, but the practice of the office is to measure net quantities and allow in price for the wastage.

COST.

The cost of carpenter-work is dependent on the price of lumber in the locality where required, the market prices differing greatly in most cities, Chicago being considered the cheapest market for framing lumber, especially that grown in the lake regions. Redwood, which is so plentiful on the Pacific slope that it is often used for framing, boarding, etc., is so costly in the Eastern States that it is seldom used, and then principally for interior finishing wood and shingles; the cost, of course, being occasioned by the transportation for such a great distance.

Pine floor-joists, with the rough boarding over same, will average about 3′ 6″ board measure per square foot of floor area, and cost about 2c. to 3c. per foot board measure put in place, or 7c. to 10c. per square foot of floor area.

Stud partitions, 3″ x 4″ x 16″ on centres, will average 1′ board measure to 1 square foot of wall, and cost, put in place, about same as floor-joists, 2c. to 3c. per foot.

Roof-framing, trusses, boarding, etc., will average from 4′ to 6′ board measure per square foot of roof-surface, and cost about 4c. to

6c. per foot board measure, or 15c. to 30c. per square foot of roof-surface dependent on framing and trusses.

1882, Albany Southern pine floor-joists, 4½c. a foot board measure, put in place.

1882, Paducah, Ky., oak floor-joists, $1\frac{6}{10}$c. per foot board measure, furnished.

1886, Baltimore rough pine lumber, $13 per thousand feet.

Lapped-siding costs from 5c. to 7c. per square foot, put in place, and trimmings, mouldings, etc., may be estimated at about 12c to 15c. per square foot, put in place.

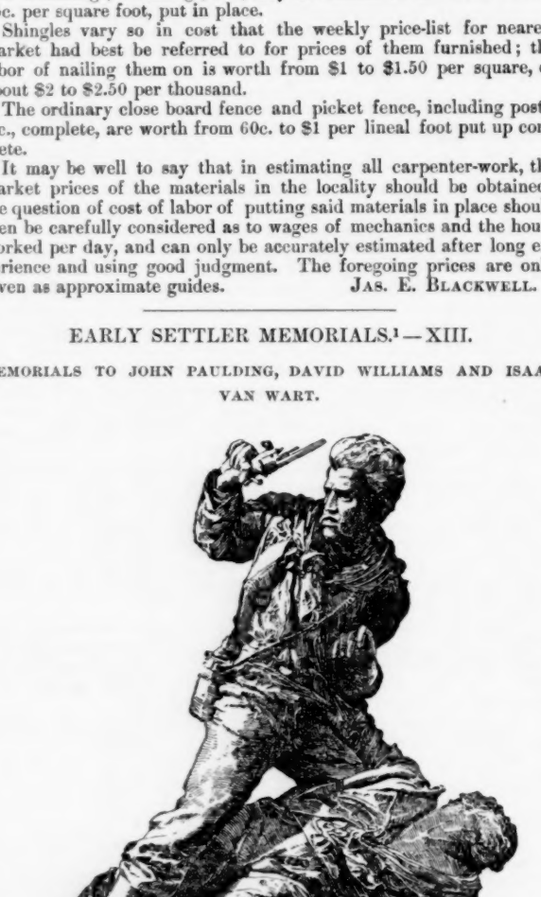
Shingles vary so in cost that the weekly price-list for nearest market had best be referred to for prices of them furnished; the labor of nailing them on is worth from $1 to $1.50 per square, or about $2 to $2.50 per thousand.

The ordinary close board fence and picket fence, including posts, etc., complete, are worth from 60c. to $1 per lineal foot put up complete.

It may be well to say that in estimating all carpenter-work, the market prices of the materials in the locality should be obtained; the question of cost of labor of putting said materials in place should then be carefully considered as to wages of mechanics and the hours worked per day, and can only be accurately estimated after long experience and using good judgment. The foregoing prices are only given as approximate guides. Jas. E. Blackwell.

EARLY SETTLER MEMORIALS.[1]—XIII.

MEMORIALS TO JOHN PAULDING, DAVID WILLIAMS AND ISAAC VAN WART.



Monument to the Brothers Cairoli, Rome, Italy. Ercole Rosa, Sculptor.

NO incident in the war of the Revolution awakened so deep an interest at the time of the occurrence, or has become so important a part of American history, as the capture of Major André. "The happiness and progress of mankind have as often been advanced or retarded by small events as by great battles. Three hundred men, led by Leonidas, stemmed the Persian torrent at Thermopylæ; in 1780 three farmers preserved the liberties of the American people.

The month of September of that year was a gloomy and anxious time for Washington and Congress. Charleston had fallen, Gates had been disastrously defeated, and the whole South had come under British control. New Jersey was overrun, and twenty thousand of the enemy's veterans were gathered in New York City. The French fleet had sailed away, a large reinforcement to the British navy had arrived, and Washington's cherished plan of attacking the city had to be abandoned. The only American force worthy the name of an army, numbering less than twelve thousand men, suffering from long arrears of pay, without money to send their starving families, and short of every kind of supplies, was encamped at and about West Point. The capture of this post, controlling the passes of the Hudson, with its war materials, vital to the maintenance of the patriot army, and its garrison of four thousand troops, including the person of Washington, would end the war, in the judgment of many British generals and statesmen.

[1] Continued from No. 610, page 107.

"Fortify from Canada to the city of New York," said they, "and we can hold the colonies together." "Capture and place a chain of posts along the route from New York City to Canada, and we can crush rebellious New England, and awe all the rest into submission," said the British Cabinet.

The battle of Saratoga and surrender of Burgoyne, defeated the last and most formidable attempt to accomplish this result by arms.

It was now sought to be accomplished by treason.

During the eighteen months, previous to this memorable September, Benedict Arnold, the General-Commandant of West Point, had been carrying on a correspondence, over the signature of Gustavus, with Major John André, who replied as John Anderson, Adjutant-General of the British forces, and who acted for Sir Henry Clinton. This correspondence, written in the vocabulary of trade, and treating of the barter and sale of cattle and goods, was really the haggling about the price and betrayal of the post of West Point, the liberties of the American people and the destiny of a human soul. Arnold well understood the conditions surrounding the American army and the importance of West Point, to either party. Deprived of his command in the army, a bankrupt, as the result of excesses, smarting under the reprimand of Congress, although retaining the confidence of Washington, he secured the command of West Point for the purpose of selling it to the British. The time had come for action, and the British must be satisfied as to the identity of their man and the firmness of his purpose, and commit him beyond the possibility of retreat. For, said Sir Henry Clinton, "We propose to risk no lives upon the possibility of deceit or failure."

The first meeting, appointed at Dobbs Ferry, between Arnold and André, on the 12th of September, failed, and the former came near being captured. With the audacity of a fiend, he reported his visit at once to Washington, and the next day wrote a letter to General Greene, expressing bitter indignation against Gates for his Southern defeat, and the apprehension that it would leave an indelible stain upon his reputation.

Soon after, he met Washington, on his way to see Rochambeau at Hartford, carried him across the river at Verplank's Point, in his barge, and there asked his chief's permission to attend, ostensibly, to a matter concerning some confiscated lands, but really to arrange for an interview with André; but Washington refused his permission, saying the matter had better be left with the civil authorities. Arnold, however, lurked in the bushes of the Long Cove below Haverstraw, sent a boat at midnight to the "*Vulture*," a British gunboat having André on board, to bring the latter to the shore. André, disguised in a cloak, and cautioned by Sir Henry Clinton not to go within the American lines, not to be the bearer of any papers, nor even to disguise himself, returned with the boatmen and remained with Arnold until daylight, arranging the terms of the surrender, when they repaired to the house of J. H. Smith, where the bargain was completed September 22, 1780; André receiving the plans of the fortifications, armament and troops at West Point, and the proceedings of Washington's last Council of War. He also receives the assurance that the defences of the fort shall fall without a blow, and assures Arnold, in return, of a Brigadier-Generalship in the British army and seven thousand pounds in money. Arnold returns to the fort, and André, further disguised and armed with a pass from Arnold in the name of John Anderson, crosses the river to Verplanck's Point, in company with Smith, as a guide, passes through Livingston's camp in safety and hurries on to New York.

Colonel Livingston, who commanded at Verplanck's, did not like the appearance or presence of the "*Vulture*" in that locality, and had applied to Arnold, a few days before the meeting of the conspirators, for a heavy gun to fire upon her, but being refused, he used a little four-pounder, and with such effect that she was obliged to drop down the river fifteen miles. Smith, André's guide, did not dare to attempt to reach the vessel by boat, and so the land journey was determined upon. At Crumpond, Captain Boyd, an inquisitive Yankee, stopped the travellers, and though Arnold's pass surprised him, he persuaded them to remain over night. At early dawn they departed, with Captain Boyd's advice to look out for the cowboys. At Pine's Bridge, Smith's courage failed, and he bade his companion good-by. Smith returned to West Point, reported André's safety to Arnold, continued on to Fishkill, and supped that night with Washington and his staff. André, fearing nothing from the cow-boys and being in the neighborhood of his friends, the loyalist families, struck for the river road.

On the morning of the same day, September 23, seven of the young farmers of the vicinity of Tarrytown, some of whom had served in the Continental army, heard that a number of horses had been stolen, and they formed themselves into a scouting party to intercept the thieves if they should attempt to pass with their booty to New York. Three of the party, John Paulding, about twenty years of age, Isaac Van Wart, of the same age, and David Williams, five years older, stationed themselves on the post-road at a small brook, hidden by some bushes, just above Tarrytown. Paulding was dressed in a British uniform, a yager coat, green laced with red, which had been given him by a friend in New York, after he had escaped from the British prison, four days before. They seated themselves in the bushes, and were playing cards, when they heard the footsteps of a galloping horse. On approaching the road, they saw a gentleman riding towards them. It was André. As he neared them, they cocked their muskets, aimed at him, and he checked his horse. He

was the first to speak, and said, "My lads, I hope you belong to our party." Paulding asked, "What party?" And André answered, "The lower party." To which Paulding said, "We do." André then told them that he was a British officer, who had been up in the country on particular business, and did not wish to be detained a single moment. He then showed them his gold watch as an evidence that he was a gentleman. Paulding then told him that they were Americans.

Somewhat disconcerted, André exclaimed, "God bless my soul! a man must do anything to get along, I am a Continental officer, going down to Dobbs Ferry to get information from below."

He then presented a pass from General Arnold, in which was the name of John Anderson. Seizing hold of the bridle of the horse, they ordered him to dismount, took him down ten or twenty rods from the road, beside a run of water and near a large tree, and Williams proceeded to search his hat, coat, vest, shirt and breeches, in which they found eighty dollars in Continental money; and at last ordered him to take off his boots. As Paulding drew off André's stocking, he excitedly cried out, "My God! here it is!" On examination they found three half-sheets of written paper, enveloped by a half-sheet marked "Contents, West Point." Paulding again exclaimed, with much excitement, "My God! he's a spy!" On pulling off the other stocking a similar package was found.

They now allowed him to dress and marched him across the road into a field about twenty rods, where they asked him from whom he got the papers. He replied, "Of a man at Pine's Bridge, a stranger to me." He then offered them his horse, equipage, watch and one hundred guineas, if they would give him his liberty. This they refused, unless he would tell them where he got the papers. He refused to tell, but raised the sum of money to one thousand guineas and as many dry goods as they wished, adding that they might keep him until the goods were delivered to them. They still refused. He again offered them ten thousand guineas and all the dry goods they desired. To which Paulding answered, "No! by God, you shall not stir a step; we are Americans and above corruption, and go with us you must."

They then took him to the nearest military station, twelve miles distant at North Castle, and delivered him to Colonel Jaimesen, the commanding officer.

On October 7 Washington sent to Congress a copy of the proceedings of the trial of André, with the names of his captors, and on its receipt, that body passed November 3, the following resolution:

"*Whereas*, Congress have received information that John Paulding, David Williams and Isaac Van Wart, three young volunteer militiamen of the State of New York, did, on the 23d day of September last, intercept Major André, Adjutant-General of the British army, on his return from the American lines, in the character of a spy; and, notwithstanding the large bribes offered them for his release, nobly disdaining to sacrifice their country for the sake of gold, secured and conveyed him to the commanding officer of the district, whereby the dangerous and traitorous conspiracy of Benedict Arnold was brought to light, the insidious designs of the enemy baffled and the United States rescued from impending danger,

"*Resolved*, That Congress have a high sense of the virtuous and patriotic conduct of the said John Paulding, David Williams and Isaac Van Wart.

"*In testimony whereof:* ORDERED, That each of them receive annually, out of the Public Treasury, Two Hundred Dollars in specie, or an equivalent in current money of these States, during life, and that the Board of War procure for each of them a silver medal, on one side of which shall be a shield with this inscription: 'Fidelity,' and the other the following motto, '*Vincit Amor Patriæ*,' and forward them to the Commander-in-Chief, who is requested to present the same, with a copy of this resolution and the thanks of Congress for their fidelity, and the eminent service they have rendered their country."

Shortly after Washington gave a grand dinner-party at Verplanck's Point. There were present, his staff, the famous generals of the army, and, as honored guests, the three captors, to whom, in an impressive speech, Washington presented the medals. Williams's medal is now in the State Library at Albany. Congress also gave them the sum of twelve hundred and fifty dollars, or the same value in confiscated lands in Westchester County. And the Legislature of the State of New York gave to each of them a farm in consideration of "their virtue in refusing a large sum, offered to them by Major André, as a bribe to permit him to escape."

Thus promptly and generously did the Continental and State Governments recognize and reward the deed of these men. But the feeling existing in the locality where they lived, at the time of the capture, was quite a different matter. "It is hard to understand now the condition of this region at that period. It was ominously known as neutral ground, marauded and harried by royal and Continental soldiers, and by Skinners and Cow-boys, robbers and brigands of equal infamy. The Whig farmer saw his cattle driven off and the flames of his buildings lighting the sky to-night, and mercilessly retaliated upon his Tory neighbor to-morrow. Fences were down, fruit rotted ungathered on the ground, rank vegetation covered the unsown fields, and the gaunt and vengeful citizen guarded, with ready musket, his family and hidden stores, or watched in ambuscade by the way-side, to recapture his stolen property or prevent the delivery of foraged stores to the enemy. Amidst such experiences and surroundings the captors of André passed their daily lives." The operative sentiment in Westchester County was Tory. It passively, and sometimes actively held in contempt those who were trying to rob them of one form of Government without being able, apparently, to provide another. The patriots of this vicinity when not protected in free speech and action by the presence of Continental troops, were cautious and guarded.

"When André was executed, the expression of Tory sentiment was one of execration, and even among the patriots it was thought that the sentence was unjust and that the execution was a mistake. So deeply was this feeling known to exist that the captors were never known to allude to it in other than an evasive way. They fell into the general current of opinion and had a secret misgiving that they were, in some degree, responsible for 'the vengeance meted out to André.' For years sympathy for poor André was the predominant sentiment. Had there been a proposition made at any time within the fifty years subsequent to the capture to erect a statue on the spot, it would have met with almost universal disapproval from the patriots themselves."

So writes a prominent citizen of Tarrytown; the captors were ignorant men, Paulding being the only one who could read. There are many who believe to this day that they were of that disreputable crew called "skinners," and that they were actuated by motives far different from those of unselfishly serving the patriotic cause. That André fell into their hands and was thereby prevented from consummating the bargain with Arnold was well; the rest was purely providential, but let the means by which Providence worked be forgotten is their idea. The horse and its equipments and André's watch were sold by the captors and the money divided between them and four other persons who belonged to their party and were at another point when the capture took place. The watch was bought by Col. W. S. Smith for thirty guineas at the time of André's court-martial, which took place at Tappan.

Of Van Wart little is known. He lived a highly-respected life for forty-nine years after the capture. David Williams served four years in the Revolutionary army previous to the event, and died fifty-two years after, deeply mourned for his many excellent qualities. Paulding served in several different commands before the capture, and died forty years after.

The French Lieutenant-colonel Fleury, writing from Newport in October, 1780, to his friend Peters, closes his letter, after expressing his horror at Arnold's conduct, with these words: "How great are, compared to Arnold, those *peasans* who refused the bribe from André. Let this be remembered in favor of the poor."

In 1817, a bill was introduced in the Congress of the United States asking for an appropriation of twenty thousand dollars to erect a monument to Paulding, Williams and Van Wart. It passed the House, but either did not reach or was defeated in the Senate. It was opposed in the former body by Major Tallmage because, as he asserted, the captors of André were of that class of people known as "cow-boys" or "skinners" who passed between both armies, as often in one camp as another, friendly to each as their interests might prompt, and without attachment or preference to either; that he had been told by André that, in his opinion, their search of his person was for plunder and not for evidence of his character; that if he could have paid the sum demanded by them he would have been released, and that their only motive in returning him to the American camp was the hope of a large reward. Major Tallmage stated no fact in support of his own or André's opinion. Very soon after the appearance of the above remarks, sixteen inhabitants of Westchester County, all aged and respected men who had known the captors during the Revolutionary War, united in declaring in a published document, that the assertions of Major Tallmage were not only untrue in every respect, but the captors were universally esteemed as being faithful and ardent patriots. Paulding and Van Wart were then living in Westchester County, and they also made sworn affidavits denying the charges of Major Tallmage and giving again the details of the capture.

In 1826, a Paulding Monument Committee was formed in New York City, and through its efforts the corporation of the city erected in 1827, in the old graveyard in the little village of Tappan, near Peekskill, in Westchester County, a marble monument to Paulding. It bears this inscription on its face:

HERE REPOSE THE MORTAL REMAINS OF
JOHN PAULDING,
WHO DIED ON THE 18 OF FEBRUARY, 1818,
IN THE 60TH YEAR OF HIS AGE.

On the morning of the 23 of September, 1780,
Accompanied by two young farmers of the County of Westchester,
(Whose names will one day be recorded on their own deserved monuments)
He intercepted the British spy André.
Poor himself
He disdained to acquire wealth by the sacrifice of
His country.
Rejecting the temptation of great rewards,
He conveyed his prisoner to the American camp
and
By this act of noble self-denial,
The treason of Arnold was detected:
The designs of the enemy baffled;
West Point and the American army saved;
And these United States,
Now by the grace of God free and independent,
Rescued from most imminent peril.

THE CORPORATION OF THE CITY OF NEW YORK
ERECTED THIS TOMB
AS A MEMORIAL SACRED TO
PUBLIC GRATITUDE.

On one side of the pedestal is carved a fac-simile of the face of the medal voted by Congress to each of the captors. On the opposite side the reverse of the medal is carved on a shield. The monument is made of marble and is surrounded by an iron railing and a marble coping. It is thirteen feet high and seven feet square at base. It is described "as a pedestal surmounted by a cone, the whole composed of most massive materials and fastened with iron cramps in such a manner as to resist the severity of the climate for ages to come."

The monument was dedicated on the 22d of November, 1827, in the presence of "a vast concourse of people," including many Revolutionary soldiers. Hon. William Paulding, said to be a relative, the mayor of New York, delivered the dedicatory address.

It stands in the midst of many interesting historical associations. Near by is the old, red, peaked-roofed, rectangular, wooden Episcopal church where Washington frequently worshipped. The interior of this ancient pile is unchanged since Revolutionary days, and mice and spiders are the principal occupants. The old Van Rensselaer manor house, once Washington's headquarters, is also within gunshot of the monument. T. H. Bartlett.

[To be continued.]

COMMUNICATIONS

A CORRECTION.

Boston, May 28, 1888.

To the Editors of the American Architect: —

Dear Sirs, — We are not building a *laundry* but a steamer *landing* at Belfast, Maine, for the Boston and Bangor S. S. Co., including ticket-office, waiting-rooms, etc. Will you please correct in your next issue. You may be pleased to know that the item was noticed by others than myself for we have received this morning two circulars from agent for Patent *Laundry* Systems.

Very truly yours, H. M. Stephenson.

NON-CORRODIBLE IRON.

New York, May 26, 1888.

To the Editors of the American Architect: —

Dear Sirs, — We notice your editorial mention of the hydrogen process. This process is not new and seems to produce an oxide-of-iron coating instead of a compound of hydrogen. It is fully described in United States Patents to J. P. Gill, Nos. 283,999, 284,000, 284,001. Respectfully yours, The Wells Rustless Iron Co.

SPONTANEOUS COMBUSTION OF OILED SHAVINGS.

Vineland, N. J., May 29, 1888.

To the Editors of the American Architect: —

Dear Sirs, — We notice in the *American Architect and Building News* of May 19, 1888, under the head of "Notes and Clippings," an article entitled "Spontaneous Combustion" which relates to a case which occurred at our factory, and under our own observation. We take pleasure in enclosing herewith a photograph of the burning, "taken on the spot." Since our experience as stated in the article referred to, and only recently in fact, we threw out some oiled shavings on the ground, at a safe distance from our buildings, and, after having been wet by two or three rain-storms, they burst into flame a few days ago, and were entirely consumed.

Very respectfully, Gage Tool Co.

NOTES AND CLIPPINGS

Artificial Incubation in Egypt. — One of the oldest industries in Egypt is artificial egg-hatching, principally engaged in by Copts. There are said to be 700 establishments of this nature in the country, and the production of chickens from the ovens is estimated at from 10,000,000 to 12,000,000 annually. The season for incubating lasts through three months of the early summer. The country people bring eggs to the proprietors of the "farroogs," and give two good eggs for every newly-hatched chick. — *Consular Report.*

Paris Fires in 1887. — The returns of the Paris (France) Fire Brigade state that the total number of calls for fires last year was 988, this being exclusive of 1,912 chimney fires. The damage done by these 988 fires is estimated at £172,000, this being exclusive of the Opéra Comique, the loss sustained by the destruction of which has not yet been accurately calculated. In 878 cases the losses were in whole or part covered by insurance. The report goes on to state that there are at the present time 3,558 water-plugs in the streets, with 25 depots for fire engines, and 211 calling stations. In the course of the past year 3 gold and 23 silver medals, in addition to 43 certificates of distinguished conduct, were awarded to men of the fire-brigade. The official statistics put the number of deaths by the burning of the Opéra Comique at 79, and of the persons taken out alive at 211: but this is very much below the reality. — *New York Evening Post.*

TRADE SURVEYS

It is probable that reductions in wages will be made in nearly all classes of labor, excepting in the building trades, before the close of the summer. In those branches controlled by schedules slight reductions are expected to be made. The railroads have reduced freight-rates on between 30,000 and 40,000 miles of road; part of these reductions have been due to rate wars. The conflict between the railroads in the Northwest continues, and there rates are lower than they have ever been. It is not probable that these troubles will extend to other sections. There is, at this time a surplus of labor in nearly all of the Western towns and cities for which there are no immediate prospects of employment. Employers have a better opportunity to rearrange rates of compensation than they have had for several years, but advantage will be taken of this temporary oversupply of labor only where competition forces such action. The general desire among manufacturers and employers of labor is to continue at present rates, but reductions have been rendered necessary by the declining tendency in prices, and by the general restriction of demand. The industries are in a healthy condition; lessened consumption has been met by a lessened production, and the financial relations between buyers and sellers have not been seriously disturbed as yet. There is a spirit of accommodation among business men which promises well for the future; there is no disposition to crowd; jobbers are willing to extend credits; manufacturers are willing to do their best with buyers; but everywhere bottom prices are insisted upon and forward requirements are covered only in exceptional cases. One striking feature of the market is that there are little or no accumulations of stocks; when the turning-point comes, it will find both producers and consumers practically bare. In former depressions this has not been the case; in every one with which the country is familiar, the first difficulty to be gotten over, when an improvement has set in, has been the consumption of accumulated goods and merchandise. The people, or rather, the manufacturers, have learned valuable lessons from the mistakes of the past, and for months have been restricting production and avoiding any accumulations. It is for this reason that the prediction is made in a good many business circles that business will begin to improve early in the fall. Probabilities point that way. A great deal of railroad-building would be pushed now but for the uncertainties existing as to price of material of all kinds, as to abundance of money, as to the balance of trade, and as to tariff duties. Several million dollars will be invested in railroads, not only in the Southwest, but the Northwest and in localities where we are now told that railroad-building has been overdone. This over-construction of railroads may exist with reference to long or trans-continental lines, but it is not true with regard to short lines in any section of the country. There is need of a good deal more railroad mileage than the country possesses, and railroad managers and investors in railway bonds and stocks are fully convinced of this fact. It is this that gives the strong tone to the railroad bond and stock market in the face of poor and unpromising earnings. Architects in a number of the leading Western cities report a sluggishness with reference to new enterprises. They say that material is cheap enough, money abundant enough, prospects favorable, and conditions healthful, and yet there is an unaccountable holding back in large building enterprises for which they are unable to offer any intelligent explanation. There is considerable activity in Chicago, but not such as the builders there have anticipated; St. Paul and Minneapolis are ahead of last year's figures; Omaha reports considerable activity; Kansas City is doing remarkably well in some lines. One good authority states that outside of Denver, Salt Lake City, Tacoma, and the cities above mentioned, there is really no genuine industrial or building activity. This may be putting the case rather too strongly, but the fact remains that just now there is a conservatism prevailing among managers of industrial enterprise and builders that is somewhat discouraging for those who indulged in high hopes at the opening of the year. There is but little room for a decline in building material; lumber is about as low as it can go; iron and steel of all kinds are selling at very little above cost. The real-estate speculative era is past and desirable lots and land are now to be purchased in many cases at fifty per cent less than twelve months ago. The development of railroads has brought a great deal of desirable territory within reach and builders and buyers are offered abundant opportunities for selection. In the wheat regions of the Northwest there is a great deal of elevator-building promised. The boat-builders along all of the lakes are doing more work than for years. The large machinery establishments are also very busy West and East. Taking the industrial situation all through, we find less activity, more conservatism, and a more careful study of future requirements. Most of the returns from railroads for the past few weeks have been of an encouraging character, but it is altogether probable that unfavorable returns are withheld. The newspapers are interested in brushing aside the dark clouds in the horizon. Wall Street traders are much better informed than the writers in newspaper offices, and from them some interesting points can be learned. The pith and substance of the latest responsible utterances is that railroad securities will improve in value within twelve months, under the better management and greater economies introduced. Foreign investors, who seldom make a mistake, are showing their confidence in American securities by liberal purchases. Gold is going abroad, but there is an abundance in the interior to stand a long drain. Our export trade is against us, but this signifies nothing for the present. The foreign demand for the farm-products of the Northwest will probably keep prices of cereals at their lower rather than their higher limits. No matter in what channel of trade soundings are taken, we find sufficient evidence to justify the confidence which is generally felt in the steadiness of prices and an expansion of demand as soon as the present depression shall have had a chance to exhaust itself. The lack of confidence so far as present transactions are concerned, is a necessity, and is having a healthful result. All speculative values are being squeezed out and the controllers of our industries and masters of transportation understand thoroughly that the present corrective agencies at work are rendering good service to them and to all legitimate enterprise. The weakness of the commercial situation in past decades has been due to the fact that there were thousands of lame traders and manufacturers. The strength of the situation for the next five or ten years will be due to the absence of that kind of competition. The associations and combinations and trusts are helping to drive this element out of the way, and in this respect they are doing good service, although possibly threatening the interests of the people in another.

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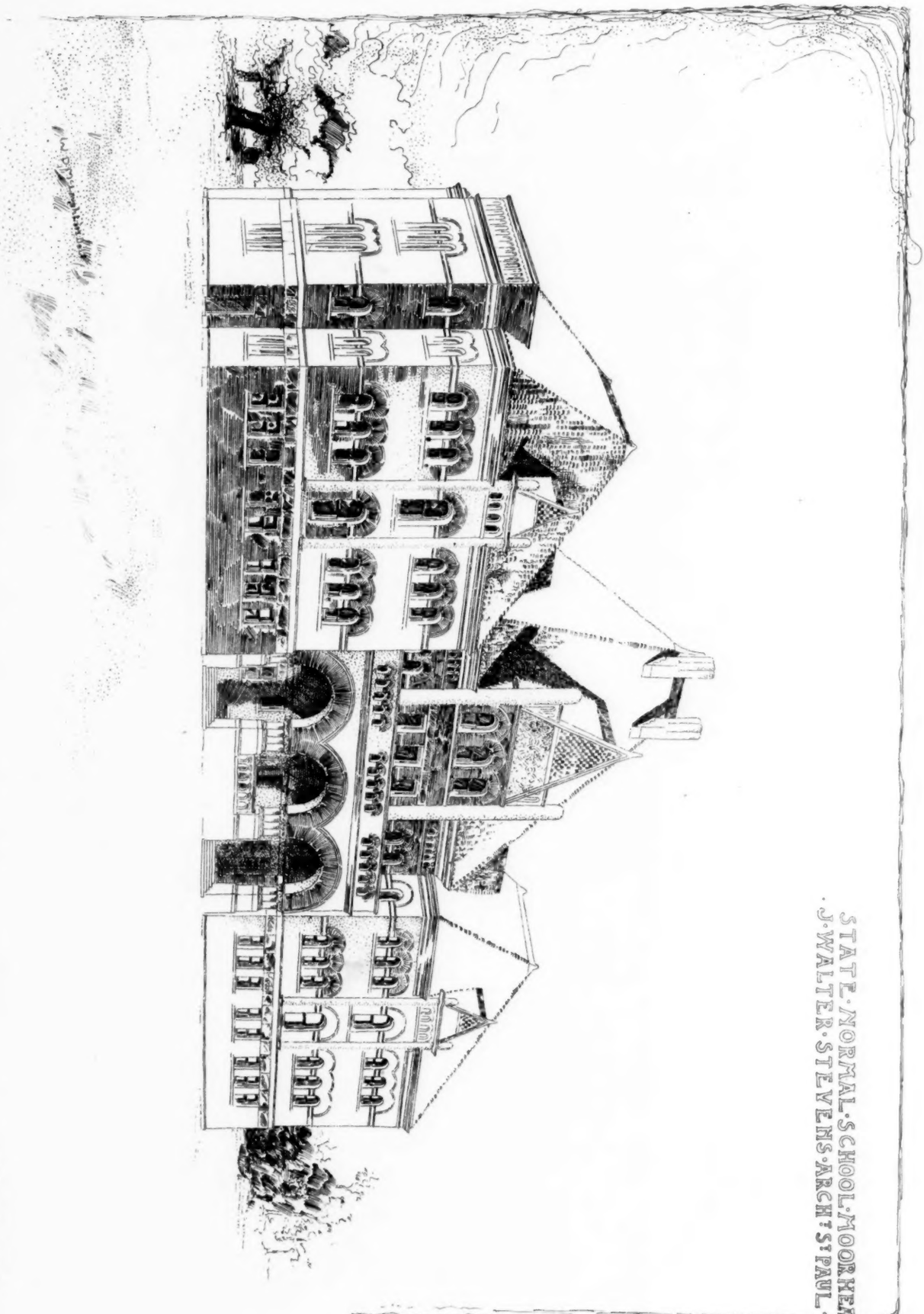

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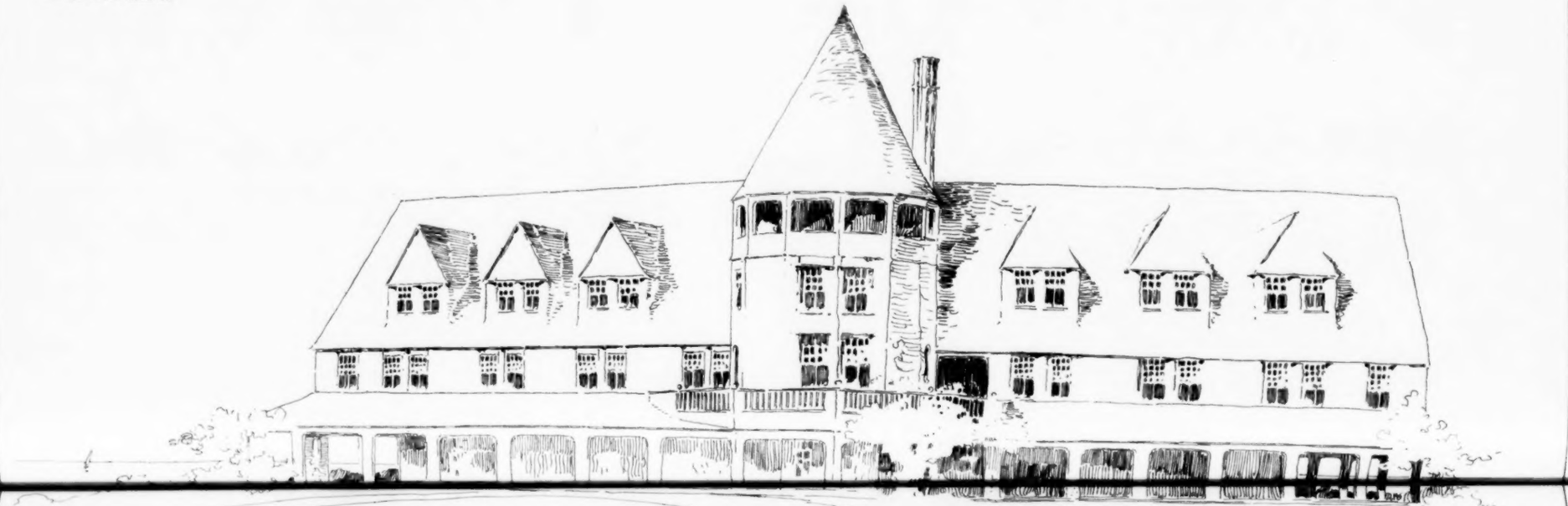

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· DESIGN · for · N · Y · ATHLETIC · CLVB'S ·
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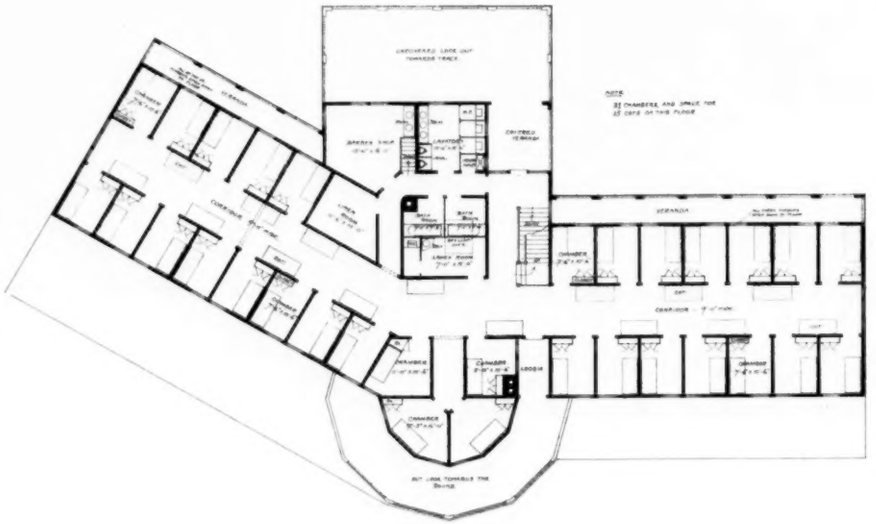

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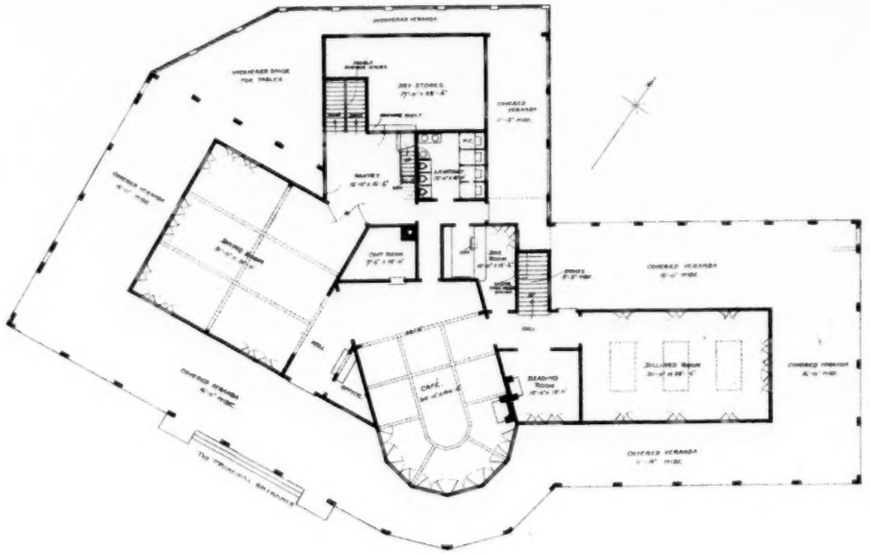

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